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STUDIES IN ORNAMENTAL TREES AND
SHRUBS.

BY

HARVEY MONROE HALL.

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INTRODUCTION AND ACKNOWLEDGMENTS.

The people of California are slowly coming to a realization of the fact that the climatic and soil conditions of this state are suitable for the growth of the best ornamentals that the world affords, and that they have the opportunity here to develop a high-class system of landscape gardening. This realization is leading to a demand for more information concerning the better sorts of ornamental shrubs and trees. The object of the present paper is to aid in supplying such information and is at the same time a critical botanical study of the species here presented.

Many of our best ornamentals are scarcely known outside of the grounds of a few wealthy citizens who have introduced them for their own pleasure, others are appreciated only by certain communities. Some of these desirable sorts are here given attention in order that their use may become more general. It is especially hoped that small grounds and yards may be planted with only the best, but it is also hoped that those interested in laying out villa sites, public parks, school-grounds, cemeteries, railroad parks, and the like, will be stimulated to more care and discrimination in the selection of trees and shrubs, since their choice affects the pleasure of many people throughout many years.

Aside from their ornamental value, many of the plants mentioned in this paper will doubtless be found useful in the work of reforestation. Several species of *Hakea*, and especially the more drought-resistant sorts of *Pittosporum* and *Melaleuca*, are among the most promising shrubs and small trees for chaparral planting in our foothill districts. Certain of the plants here considered will be of much value in California, when better known, because of their edible fruits or nuts. This particularly applies to *Feijoa Sellowiana*, and to *Macadamia ternifolia*, both trees of high ornamental value.

The greatest confusion exists among California gardeners, nurserymen, and architects, concerning the names of many of our plants. This is due, in part, to the fact that they are not grown in eastern or European gardens; hence they are not described in the standard gardening dictionaries. For most of

the groups here treated, easy, artificial keys to the species have therefore been prepared, and many illustrations added.

The garden investigations were undertaken as a part of the author's duties as assistant botanist to the Agricultural Experiment Station of the University of California. Financial aid was received from grants from the Adams Fund of the United States Government, but this paper is not to be considered as the sole result of these investigations, or even as the most important result. The critical examination of specimens gathered during the course of this study was undertaken at the University, where free use was made of the botanical library and of the herbarium.

It is a pleasure to acknowledge the assistance received from numerous nurserymen, gardeners, and other residents of California, who have allowed the writer a free examination of their plants and supplied much valuable information. Dr. F. Franceschi and Mr. W. H. Morse, of Santa Barbara, Mr. Compton of Montecito, Mr. Ernest Braunton and Mr. L. A. Greata, of Los Angeles, Mr. D. W. Coolidge, of Pasadena, Miss K. O. Sessions, of San Diego, Mr. John McLaren, Superintendent of Golden Gate Park, San Francisco, and many others should be mentioned in this connection. Among the foreign correspondents who have supplied critical notes, or specimens for comparison, it is a pleasure to mention Dr. J. H. Maiden, Government Botanist for New South Wales, Mr. T. F. Cheeseman, of the Museum at Auckland, the late Mr. H. J. Matthews, formerly Chief Forester of New Zealand, and Mr. Joseph Burt-Davy, Government Botanist for the Transvaal. Mr. C. N. Forbes, of Honolulu, has supplied valuable material from the Hawaiian Islands.

I am indebted to Mr. Harry Evans for the preparation of line drawings used in figures 1 to 13, and to Miss Carlotta Case for the one used in figure 15. The drawings used in plates 3, 4, and 5 are all the work of Mrs. Louise Nash. Of the text figures, no. 2 is adapted from Curtis' *Botanical Magazine*, plate 2246; no. 5 is from Hooker's *Icones Plantarum*, plate 447; and no. 14 is a tracing from Lindley's *Botanical Register*, plate 410. All of the others are original, drawn either from the living plant or from herbarium specimens. All line drawings used in the preparation of the plates are original, except figure 2 of plate 3.

PITTOSPORUMS CULTIVATED IN CALIFORNIA.

Pittosporum is the generic name of certain ornamental ever-green trees and shrubs which have come to us mostly from New Zealand, Australia, and the neighboring islands. About seventy species are known, of which some fourteen have found their way into California.

The popularity of these plants is due to the ease with which they are grown and to their suitability for planting in various situations. It is a remarkable fact, however, that several of the better sorts are scarcely known to our nurserymen and landscape gardeners. These have been introduced and grown on private grounds where their superior qualities are fully appreciated, but no particular effort has yet been made to extend their cultivation. It is for the double purpose of making these species better known and of providing keys and descriptions whereby any Pittosporum grown in California may be identified, that this account has been prepared.

Special Uses.

It has been said above that Pittosporums are suited to many conditions. The species adapted to special purposes may be grouped as follows:

As a street or avenue tree *P. undulatum* (the Victorian Box) has been much recommended in southern California, especially by Mr. Ernest Branton, and its rapid growth, large size, and smooth, green leaves are certainly in its favor. It will, however, require careful training and can be expected to attain stately dimensions only where abundant summer heat and some irrigation can be depended upon. A species of much greater promise is *P. rhombifolium*, of which there are now several good examples in California. This has a more erect growth with a single central shaft and pyramidal crown and is gorgeous with orange-scarlet berries for several months in each year. *P. phillyraeoides*, *P. eugeniioides*, and *P. crassifolium* may also be considered in this connection, but are not to be generally recommended.

For hedges *P. undulatum* is the best if a broad, massive hedge is desired. *P. eugeniioides* is the best in case a tall, narrow hedge

is wanted, particularly if a light-green color is preferred. *P. tenuifolium* also may be trimmed into a narrow hedge, but is more twiggy, less leafy, and of a darker green color. Both of these two last-mentioned take very kindly to pruning, making neat hedges generally superior to the much used privet and box. For low hedges and for edgings the rambling, light-green and glossy *P. heterophyllum*, a recently introduced and still rare species, should be considered.

The most fragrant Pittosporums are *P. Tobira* and *P. undulatum*. These are both sweet-scented, the fragrance resembling that of orange blossoms, while the flowers of *P. eriocarpum* have a very pleasing banana-like fragrance.

For general yard and lawn planting, where only a shrub is desired, any of the species here described may be used, except only the tree-like species and the half-reclining *P. heterophyllum*. Even such arboreous sorts as *P. crassifolium* make good shrubs if well headed in, the pruning serving the double purpose of keeping the plant within bounds and of causing it to throw out an abundance of new foliage. In case a mass of gray-colored foliage is desired, *P. eriocarpum* is by far the best.

For reforestation purposes *P. phillyraeoides* is perhaps to be recommended as of most importance because of its drought-resisting powers. It would grow readily on any of our lower ranges without attention but would need to be protected from browsing animals in its early stages. *P. tenuifolium* and *P. crassifolium* are among the most hardy species and could be used throughout the coast counties of California.

Propagation.

The seeds of Pittosporum usually germinate readily, but in California the rarer sorts are occasionally infertile. This is probably due to the absence of cross-pollination, particularly in those cases where the parent plant is the only one of the species in the neighborhood. It is claimed by some that only the spring crop of seeds of *P. rhombifolium* are fertile. *P. phillyraeoides* is perhaps the most difficult species to propagate in this way, but it throws up numerous root suckers which may be separated from the parent and transplanted.

The most rapid, and for most species the most satisfactory method is propagation by cuttings. These should be taken from the half-ripened wood and seldom fail to strike root if given ordinary care.

It is sometimes desirable to "work over" one species into another after the plant has attained considerable size. While this may possibly be accomplished by the ordinary methods of grafting, at least in some cases, the procedure known to nursery-men as inarching is more likely to prove successful.

Botanical Description of Pittosporum (Family Pittosporaceae).

Shrubs and small trees, mostly evergreen. Leaves simple, without stipules, entire or toothed, mostly alternate but sometimes so crowded as to appear whorled on the twigs. Flowers in terminal corymbs or panicles, or in axillary umbels, or solitary. Sepals 5, either distinct or united at base. Petals 5, rarely distinct to base, usually connivent or cohering in a tube. Stamens 5, free; anthers erect, ovate-oblong. Ovary sessile or short-stipitate, incompletely 2-celled (or rarely 3- to 5-celled). Style short. Fruit a globose, ovate, or obovate capsule, often compressed, sometimes colored and berry-like in appearance, the valves leathery or almost woody, the placentae central. Seeds thick or globular, not winged, smooth but usually embedded in a viscous substance, disagreeable to the taste because of the presence of an aromatic, resinous, or acrid principle. The name "*Pittosporum*" is derived from two Greek words and may be translated as "pitch seed." This term was chosen because of the pitch-like exudation of the seed-coats just mentioned.

Key to the Species of Pittosporum grown in California.

A. Color of flowers black or nearly so.

Flowers mostly axillary, i.e., each from the axil of a leaf: leaves thin, glabrous 1. *P. tenuifolium*.

Flowers in terminal clusters: leaves thick.

Leaves with recurved margins, white-tomentose beneath: capsule $\frac{3}{4}$ to $1\frac{1}{4}$ in. long, tomentose 2. *P. crassifolium*.

Leaves with flat margins.

Capsule $\frac{3}{8}$ in. long, pubescent: leaves white-tomentose beneath 3. *P. Ralpii*.

Capsule $\frac{3}{4}$ to 1 in. long, glabrous: leaves glabrous when mature 4. *P. Fairchildii*.

B. Color of flowers white, greenish, or yellow.

Leaves very obtuse, thick and leathery.

Flowers $\frac{3}{8}$ in. long, in terminal umbels, usually pure white.

Foliage uniformly green 5. *P. Tobira*.

Foliage variegated with white 5. *P. Tobira variegatum*.

Flowers $\frac{3}{8}$ in. long, in terminal panicles, greenish yellow 6. *P. viridiflorum*.

Leaves acute, thin.

Flowers in terminal clusters: leaves lanceolate or broader.

Young foliage glabrous or nearly so.

Petals about $\frac{1}{2}$ in. long: flowers rather few (rarely over 20 in each terminal cluster). 1

Capsule many-seeded: flowers white, fragrant 7. *P. undulatum*.

Capsule 4-seeded: flowers greenish yellow.....8. *P. tetraspermum*.

Petals less than $\frac{1}{4}$ in. long.

Leaves entire or merely undulate: sepals acute.

Erect, with leaves $2\frac{1}{2}$ to 4 in. long.....9. *P. eugenoides*.

Half-reclining, with leaves 1 in. long....10. *P. heterophyllum*.

Leaves coarsely toothed: sepals obtuse.....11. *P. rhombifolium*.

Young foliage and capsules very pubescent.

Leaves 7 to 10 in. long, abruptly narrowed to a long petiole
.....12. *P. hawaiiense*.

Leaves smaller, tapering to the petiole.

Tomentum rusty: leaves 2 to 3 in. long 13. *P. revolutum*.

Tomentum white: leaves 4 to 6 in. long 14. *P. eriocarpum*.

Flowers axillary, i.e., each from the axil of a leaf.

Leaves glabrous, flat: flowers yellow 15. *P. phillyraoides*.

Leaves tomentose underneath, margins rolled back: flowers purple
and yellow 16. *P. bicolor*.

1. *P. tenuifolium* Gaertn. *P. nigricans* Hort.

A shrub or small tree, rarely exceeding 30 ft., of symmetrical and compact growth: bark black: leaves glabrous and shining when mature, oblong or somewhat obovate, acute or rarely obtuse, 1 to 3 in. long, thin or almost membranous, the margins wavy: flowers solitary in the leaf-axils or rarely fasciated: corolla $\frac{1}{4}$ to $\frac{1}{2}$ in. long, dark purple: ovary silky: capsule $\frac{1}{2}$ in. long, globose, 3-valved, glabrous and minutely roughened when mature. New Zealand.

One of the best sorts for mass planting and for hedges in California. Its clean, thrifty growth makes it desirable for planting near houses and especially for screening undesirable views. An occasional judicious pruning is necessary in order to get a good foliage effect and to hide the stems.

A yellow-flowered form of this species has just been discovered in Berkeley by Miss Katherine Jones. It is represented by but two shrubs growing in a row of normal black-flowered plants, and no other difference can be detected. It will be further studied and propagated for distribution, since the yellow flowers render it more attractive than the ordinary sort. Mr. T. F. Cheeseman, who has made a careful study of the New Zealand species, writes that although he has not known *P. tenui-*

folium to produce yellow flowers, he has noted this variation in other dark-flowered species. He has, therefore, no hesitancy in referring our yellow-flowered form to *P. tenuifolium*.

2. *P. crassifolium* Soland. KARO.

A tall shrub or small tree, 15 to 30 ft. high, with erect branches: bark dark brown or black: branchlets, petioles, lower surface of leaves, inflorescence, and ovaries all densely clothed with a white or buff downy pubescence: leaves 2 to 3 in. long, narrow-obovate or oblong, obtuse, much narrowed to the short stout petiole, very leathery, dark green and shining above, the margins recurved: flowers in clusters terminating the branchlets: petals $\frac{1}{2}$ in. long including the recurved tips, nearly black: fruiting peduncle stout, recurved: mature capsule subglobose, $\frac{3}{4}$ to $1\frac{1}{4}$ in. long, short-hairy, with very thick woody valves. New Zealand. Illustrations: *Bot. Mag.*, pl. 5978 (wrongly colored); Kirk, *Forest Fl. N. Z.*, pl. 14; *Gard. Chron.*, ser. 3, xxx, fig. 130.

Too coarse and rigid for ordinary yard planting unless frequently pruned back, but with care it may be made to assume a rounded, bushy form which is very pleasing. Suitable for windbreaks and shelter near the sea. In New Zealand (where a yellow-flowered form occurs) it is said to resist the fiercest gales and to grow even where washed by salt spray. The wood is white and tough, used for inlaid work, and is difficult of combustion.

3. *P. Ralphii* T. Kirk.

A loosely branched shrub 8 to 15 ft. high: leaves spreading, 2 to 5 in. long, oblong or oblong-obovate, the margins not recurved: petioles and peduncles rather slender: capsule $\frac{3}{8}$ in. long, broadly ovoid, pubescent. New Zealand. Illustration: *Gard. Chron.*, xxvi, fig. 72 (probably this).

Rare in cultivation. I have seen one specimen on the Hale grounds, Santa Barbara, imported through the Brisbane Botanic Gardens. It is more thrifty and apparently of better habit than *P. crassifolium*. *P. Ralphii* differs from that species in that "the leaves are much larger, oblong, not gradually narrowed into the petiole, and the margins are flat, not recurved, while the capsules are much smaller" (Cheeseman). The Santa Barbara plant bears out this statement except that the leaves are narrowed to the petiole.

4. *P. Fairchildii* Cheesem.

A compact round-topped shrub 8 to 15 ft. high; leaves 2 to 3 in. long, obovate to elliptic-oblong, broader than in no. 2, glabrous when mature, the margins flat; capsule $\frac{3}{4}$ to 1 in. long, becoming glabrous when half-grown: otherwise like *P. crassifolium*. New Zealand.

This species has not yet made its appearance here, but is certain to be introduced from New Zealand, where it is grown in gardens. More graceful and compact than *P. crassifolium* and perhaps better suited to general planting.

5. *P. Tobira* Ait. TOBIRA. JAPANESE PITTOSPORUM.

A large spreading shrub with shining dark-green or variegated foliage: bark gray: leaves 2 to $3\frac{1}{2}$ in. long, 1 to $1\frac{1}{2}$ in. wide, obovate and very obtuse, gradually tapering to the short petiole, thick and leathery, the margins recurved, perfectly glabrous: flowers in terminal umbels, fragrant: corolla $\frac{3}{8}$ in. long, white or rarely yellowish: capsule $\frac{1}{2}$ in. long, ovoid, 3- or 4-angled, densely short-hairy, tipped with the persistent style. China and Japan. Var. *variegatum* Hort. has the leaves (often thinner) variegated with white. Illustrations: *Bot. Mag.*, pl. 1396; Nicholson, iii, fig. 193 (pot plant); Bailey, fig. 1837; Engler & Prantl, *Nat. Pfl.*, iii, 2a, fig. 62.

Especially valuable because of its deep-green foliage and abundant fragrant flowers, these latter resembling orange blossoms, both in appearance and odor. Suitable for lawns and shrubberies rather than for hedges. Dr. Franceschi states that it withstands violent saline winds better than most other shrubs and is therefore adapted to seashore planting.

6. *P. viridiflorum* Sims. *P. sinense* Desf. GREEN-FLOWERED PITTOSPORUM.

Much like *P. Tobira* but becoming larger, more tree-like and with smaller greenish and yellow flowers in dense compound clusters: ripe capsule subglobose, "glabrous, as large as a pea. 2- to 6 seeded." South Africa. Illustrations: *Bot. Mag.*, pl. 1684; Nicholson, iii, fig. 194.

Very rare as yet in California gardens but one of the best of the larger Pittosporums. A magnificent specimen in Santa Barbara, remarkable for its graceful habit and lively-green, glossy foliage, is 25 feet high, the trunk 10 inches in diameter. The very fragrant flowers are borne profusely during the winter and spring months but the tree sets no fruits, perhaps owing to the absence of pollen from other trees.

7. *P. undulatum* Vent. VICTORIAN BOX.

Normally a tree, attaining 40 ft. or more, commonly pruned as a shrub in cultivation, with rich deep-green dense foliage: bark gray: leaves 3 to 5 in. long, 1 or 2 in. broad, oblong, abruptly acute, coriaceous and shining, crowded on the branchlets, glabrous, entire, wavy-margined or flat: flowers rarely more than 20 in the compound terminal cluster, fragrant at night: sepals more than $\frac{1}{2}$ as long as corolla, tapering to a slender tip: corolla white, about $\frac{1}{2}$ in. long: capsule barely $\frac{1}{2}$ in. long, nearly globose, smooth, many-seeded. Australia. Illustrations: *Bot. Reg.*, i, 16; Bailey, fig. 1836.

Very suitable for large hedges where a dense foliage effect is desired; stands pruning well, and so can be kept low, but a much greater breadth will be necessary than if *P. eugenioides* is used. Blossoms with us from January to July, the rich jasmine-like odor, particularly noticeable on quiet evenings, making it suitable for planting in small groups or for individual bushes near summer houses, dining porches, and the like. It is also recommended as an avenue tree for southern California where, with plenty of room and careful pruning from beneath, it attains stately dimensions.

8. *P. tetraspermum* Wight & Arn. MADRAS PITTOSPORUM.

A large shrub: leaves 2 to 4 in. long, ovate or lanceolate, very acute, coriaceous, glabrous, the margin obscurely wavy: flowers in a terminal cluster: sepals minute, tapering to a slender tip: corolla yellowish: capsule nearly globose, glabrous, only 4-seeded. India. Illustration: Wight, *Icon.*, iii, pl. 971.

Introduced in 1897 by Dr. Franceschi, but since lost.

9. *P. eugenioides* A. Cunn. TARATA.

A small branching round-headed tree, 20 to 40 ft. high in its native habitat; a tall shrub or slender open tree in cultivation, the rather sparse and glossy foliage of a very light-green color: bark nearly white on the old branches, pale brown on the twigs: leaves 2 to 4 in. long, $\frac{3}{4}$ to $1\frac{1}{4}$ in. wide, elliptic-oblong, acute, often conspicuously wavy-margined: flowers numerous in a branched terminal cluster: sepals minute, obtuse: corolla yellowish, under $\frac{1}{4}$ in. long: capsule rather more than $\frac{1}{4}$ in. long, ovoid, pointed at each end, 2- to 4-ribbed, glabrous when mature. New Zealand. Illustration: Kirk, *Forest Fl. N. Z.*, pl. 49.

The most extensively cultivated species in California, a favorite because of its hardness and the yellowish green color of the foliage. Its slender habit and cheerful appearance renders

it especially valuable where something is needed to relieve the somber appearance of our ordinary dark-green shrubbery. When grown for hedges the plants should be set not more than three feet apart and the lateral branches clipped back occasionally; in a few years it may be trimmed to a narrow hedge. The fragrance, said to be very noticeable in wild trees, seems to be lost in cultivation. "The wood is white, tough, elastic, and of considerable strength, but soon perishes when exposed. It is frequently used by the wood-turner" (Kirk).

10. *P. heterophyllum* Franch.

A low, half-reclining shrub or low hedge plant with light-green foliage: leaves 1 or 2 in. long, $\frac{1}{2}$ to 1 in. broad, lance-shaped or ovate, tapering to both ends but nearly sessile, entire, glabrous: flowers few in simple clusters terminating short branchlets, the peduncles only very rarely divided: corolla light yellow, about $\frac{1}{4}$ in. long: capsule barely $\frac{1}{4}$ in. long, globose, minutely pubescent when half-grown, glabrous at maturity. Western China.

Introduced by Dr. Franceschi in 1908, his specimens with small ovate leaves. In China the leaves are extremely variable in size and shape, even on the same branch. Dr. Franceschi recommends it for large rockeries and embankments, and states that it is drought resistant.

11. *P. rhombifolium* A. Cunn. QUEENSLAND PITTOSPORUM.

A tree of pyramidal growth, said to reach 60 to 80 ft. in height: leaves 3 to 4 in. long, 1 or 2 in. wide, rhomboid, being broadest in the middle and tapering to each end, acuminate, coarsely and irregularly toothed, glabrous: flowers numerous in a wide compound terminal cluster: sepals rather obtuse, about one-half as long as the corolla, this $\frac{1}{8}$ to $\frac{1}{4}$ in. long and white: capsule berry like, $\frac{1}{4}$ in. long, nearly globose, tipped by the persistent style and rounded to a short-columnar base, passing from green through lemon color to bright orange-yellow, glabrous. Australia. Illustration: Hooker, *Icon.*, pl. 621.

Little known in California but one of the very best sorts. Sometimes grown as a pot plant, in which case it remains small, and serviceable when young as a shrub, since it flowers when only 5 or 6 feet high, but most valuable for avenue planting and as a specimen tree for lawns and yards. Its central shaft gives it an erect habit, the foliage is clean and thrifty, the flowers not very showy and rather faintly odorous, the bright-yellow berries

very conspicuous and the most pleasing feature of the tree. The flowers appear in June and July and the berries persist through the autumn and winter. These berries contain but few fertile seeds, although there is a small spring crop in which the percentage of viability is greater. This species is also propagated by cuttings. Specimens may be seen at the Gould place, Montecito; the Sexton place, Goleta; at Soldiers Home near Los Angeles; and at the Fowler place, Pasadena.

12. *P. hawaiiense* Hilleb.

A small tree 12 to 15 ft. high, with few branches: leaves of the largest, being 7 to 10 in. long and 2 to 3 in. wide, acute, thick, slightly hairy beneath when young or even silvery white in one form, entire: flowers in terminal clusters: corolla cream color: ovary tomentose: capsule 1 in. long, probably globose, rough. Hawaii.

Introduced by Dr. Franceschi in 1907. A promising Pittosporum but probably tender and not very well known.

13. *P. revolutum* Ait.

A tall shrub, the young branchlets and petioles and the flower-stalks covered with short rusty hairs: leaves 2 to 3 or 4 in. long, 1 to 1½ in. wide, elliptic, narrowed to each end, entire or slightly wavy-margined, glabrous above when mature, rusty-pubescent underneath, crowded towards the ends of the branchlets: flower-clusters terminal, rarely a few in the axils of upper leaves: sepals with very slender tips: petals ½ in. long or rather more, pale yellow, often united part way to form a cup-shaped corolla, the free tips recurved: ovary very hairy: capsule ½ to ¾ in. long, with numerous red or brown seeds. Australia. Illustration: *Bot. Reg.*, iii, pl. 186.

Grown in England as a greenhouse shrub but flourishes out of doors at Berkeley. Not particularly desirable except in collections.

14. *P. eriocarpum* Royle.

A large bush or widely spreading bushy tree 10 to 20 ft. high, with light-green foliage and light-gray bark: leaves 4 to 6 in. long, 1½ to 2½ in. wide, elliptic or oblong, narrowed to each end, the margins either minutely wavy or flat, tomentose when young, becoming smooth at least above in age: flowers numerous in an oblong terminal raceme, very fragrant, their stems densely white-tomentose: sepals small, acute: petals yellow, somewhat exceeding ½ in., forming a tubular corolla, the tips recurved: ovary very hairy: capsule ¾ in. long, nearly globose, rough but nearly glabrous. Himalayas. Illustration: *Bot. Mag.*, pl. 7473.

So far as I know there are but two specimens of this species in California, one at the Gillespie place, Montecito, one in Elysian Park, Los Angeles. Both are noble examples and should incite to further planting. Where a mass of light-colored foliage is desired nothing could be more effective and the fragrance of the banana-scented flowers is very pleasing.

15. *P. phylliracoides* DC. NARROW-LEAVED PITTOSPORUM.

A graceful tree with habit of the weeping willow but evergreen, 20 ft. or more high, the bark smooth and gray on the branches, becoming checked on the trunk: leaves light green, 2 to 3½ in. long, about ¼ in. wide, linear, tapering to the base, acuminate and the slender tips recurved, entire, equally distributed over the slender pendant twigs, glabrous: flowers fragrant, pediceled, solitary in the leaf-axils (several in each axil in some Australian specimens), the tube ¼ in. long and the recurved portion ¼ in., yellow: sepals minute: capsule about ½ in. long, oval, compressed, the base somewhat heart-shaped, yellow, the surface granular. Australian deserts. Illustrations: Pl. 1; Maiden, *Forest Fl. N. S. W.*, pl. 4.

This remarkable tree was introduced perhaps in the seventies but its value has been appreciated only within the last year or two. Eminently adapted to dry places and should be tried in our desert country, where, however, it cannot be expected to reach the size attained in the coast counties. The foliage is too sparse for a good shade tree but its slender, pendant branches recommend it as a substitute for the weeping willow, where an evergreen is desired. Propagation from seeds is effected with some difficulty in California, but young plants are now offered by several of the nurseries at Santa Barbara and Goleta. The abundant root suckers may be transplanted if one goes to a considerable depth in digging them, for this tree is deep-rooted. In Australia a sort of bread is prepared from the pulverized seeds and the leaves are browsed by live stock.

16. *P. bicolor* Hook.

A small tree, sometimes 40 ft. high in its native habitat, sometimes only a bush, the young twigs hoary or rusty with a close tomentum: leaves 1 or 2 in. long, about ¼ in. wide, linear, acute, entire but the margins rolled back, glabrous above, tomentose beneath: flowers solitary or several in the leaf-axils: petals ½ in. long, spreading or recurved above, yellow and purple: ovary very hairy: capsules rounded, red and berry-like, "about the size of peas," somewhat compressed. Australia.

Rare in cultivation; once grown at Lincoln Park, Oakland. Hardy in southern England.

HAKEAS CULTIVATED IN CALIFORNIA.

The Hakeas are all evergreen shrubs and natives of Australia, where about one hundred species are known. Those so far introduced into California, eleven in number, are here grown exclusively for ornamental purposes, although several of them (particularly *H. suaveolens* and *H. gibbosa*) could be used to advantage as a chaparral covering for many of our lower mountains and foothills. These species are quite hardy, require neither abundant moisture nor cultivation, and, through their rigid, spiny foliage, are well protected from animals.

The ornamental value of *Hakea* lies chiefly in its foliage. This is exceptionally beautiful in the broad-leaved *H. elliptica*, where the new growth is of a most beautiful bronze color, or in some lights almost golden. It is a very satisfactory subject for lawn or yard planting where something aside from the usual dull green is desired. *H. nitida* with its holly-like, bright-green leaves is also to be considered in this connection, while if a pale green is desired *H. undulata* should be chosen. The last three species treated in this paper are also grown for their foliage but should be used only where a rigid effect is desired or as a hedge impenetrable to animals and pedestrians.

The only species with showy flowers, so far as our forms are concerned, is *H. laurina*, and even here our interest is aroused more by the oddity of the flower than by its beauty. The abundant scarlet balls of flowers emitting the long golden styles are sometimes two and one-half inches in diameter and render this a most striking shrub, so much so that in Italy it has been referred to as "the glory of the gardens of the Riviera." The remaining species have mostly smaller white flowers.

Botanical Description of Hakea (Family Proteaceae).

Australian evergreen shrubs with alternate ex-stipulate leaves of diversified shape, being flat and broad in some species (and then either entire or merely toothed), terete in others (and then either simple and entire or pinnately parted). Pubescence mostly of appressed hairs attached by the middle, or the plant glabrous. Flowers in pairs, the pairs commonly crowded in close racemes or globose clusters which are mostly sessile in the leaf-axils. Corolla irregular, the tube slender, usually recurved under the limb which is mostly globular, the 4 lobes cohering

long after the tube has opened. Anthers sessile in the base of the concave perianth-lobes. Ovary stipitate or nearly sessile. Style either long and protruding or short, dilated at the end. Fruit a hard woody capsule, opening in 2 valves. Seeds 2, compressed, winged above, the wings sometimes continued down the sides.

Key to the Species of Hakea grown in California.

A. Leaves mostly $\frac{1}{2}$ in. or more wide (narrower only in *H. saligna*).

Margins of leaves entire and flat.

Leaves pinnately veined, or the veins obscure: flowers white.

Foliage pale: leaves entire, obtuse, callous-tipped: corolla recurved 1. *H. saligna*.

Foliage bright green: leaves sometimes toothed, sharp-pointed: corolla straight 2. *H. nitida*.

Leaves parallel-veined: flowers crimson.

Veins 3 to 7: flower-clusters globular: capsule $\frac{3}{4}$ in. or more broad 3. *H. laurina*.

Veins numerous: flower-clusters oblong: capsule $\frac{1}{2}$ in. broad 4. *H. multilineata*.

Margins of leaves wavy (undulate).

Leaves veinless or obscurely feather-veined 2. *H. nitida*.

Leaves several-nerved from the base and with numerous cross-veinlets.

Margins merely wavy; petiole short or none 5. *H. elliptica*.

Margins wavy and prickly-toothed 6. *H. undulata*.

B. Leaves terete or very narrowly linear, seldom $\frac{1}{8}$ in. wide, sharp-pointed.

Veins several, parallel: leaves flat, about $\frac{1}{8}$ in. wide 7. *H. ulicina*.

Veins wanting: leaves terete.

Leaves thick, mostly pinnately parted and the lobes terete 8. *H. suarcorens*.

Leaves slender, entire.

Corolla glabrous:¹ capsule ovate, $\frac{1}{2}$ in. or more thick.

Young branches glabrous: capsule $\frac{1}{2}$ to $\frac{3}{4}$ in. thick 9. *H. acicularis*.

Young branches hairy: capsule $\frac{3}{4}$ to 1 in. thick 10. *H. gibbosa*.

Corolla pubescent: capsule lanceolate, slenderly pointed, $\frac{1}{4}$ in. thick 11. *H. pugioniformis*.

1. *H. saligna* Knight.

A pale or grayish bushy shrub (attaining 7 ft. at Santa Barbara), glabrous or the young shoots slightly silky: leaves oblong or lance-shaped, 3 to 4 or 6 in. long, obtuse but usually with a minute callous tip, tapering at base to a short petiole, veins sometimes obscure but usually at least a medial and several oblique lateral veins more or less

¹ In using this character, care must be exercised in distinguishing between the corolla proper and the pedicel, which is also white. The pedicel is pubescent in numbers 9, 10, and 11, but the corolla is pubescent only in the last.

prominent: flower-clusters small, dense, sessile in the axils of the upper leaves: corolla glabrous, strongly recurved: capsule about 1 in. long, $\frac{1}{2}$ to $\frac{3}{4}$ in. broad, with a short incurved beak, somewhat rough, sometimes covered with conspicuous tubercles. Illustration: Fig. 1.

This makes a good foliage plant but has no special character for which it can be recommended; seldom planted.

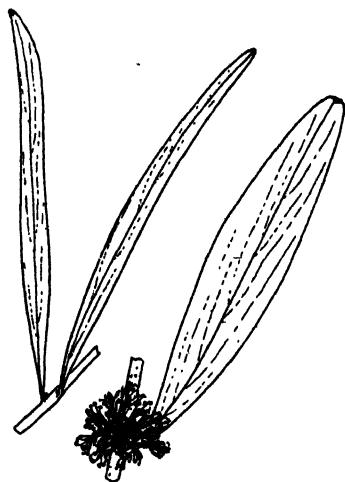


Fig. 1.—*Hakea saligna*.

2. *H. nitida* R. Br.

A large shrub with glabrous and bright-green dense foliage: leaves oblong or narrowly obovate, $1\frac{1}{2}$ to 3 or 4 in. long; either entire, obtuse, and with a small sharp tip, or with a few prickly teeth, acute, and sharp-pointed; thick and veinless or obscurely feather-veined: flower-clusters white, conspicuously stalked in the leaf-axils: corolla glabrous, straight: capsule 1 in. or more long, $\frac{3}{4}$ in. broad, with a conical horn near the end of one or both of the valves, smooth. Illustrations: Fig. 2; *Bot. Mag.*, pl. 2246.



Fig. 2.—*Hakea nitida*.

One of the earliest species introduced into England (where protection from frost is necessary). Presumably also grown in California, although no plants can now be located. The pleasing green foliage, suggestive of holly-leaves, may render it desirable.

3. *H. laurina* R. Br. *H. eucalyptoides* Meissn.

A tall shrub, attaining in Australia to 30 ft. and tree-like: branchlets gray with a minute pubescence or reddish and quite glabrous; foliage rusty pubescent when young but soon glabrous: leaves elliptic or lanceolate, narrowed to the apex which is either acute or obtuse, tapering to the petiole, often sickle-shaped, 5 or 6 in. long, $\frac{1}{2}$ to 1 in. wide; with mostly 5 or 7 parallel veins from the base and these sometimes giving off a few obscure secondary veinlets: flowers crimson, very numerous, in dense globular clusters sessile in the leaf axils: capsule ovoid, short-beaked, about $1\frac{1}{4}$ in. long by $\frac{3}{4}$ in. broad, nearly smooth. Illustrations: Fig. 3; *Bot. Mag.*, pl. 7127.

A very vigorous and striking sort with showy crimson flower-clusters from which protrude the long golden-yellow styles. Perhaps the best for dry hillsides where a chaparral covering is desired. Known on the Riviera as "Sea Urchin."

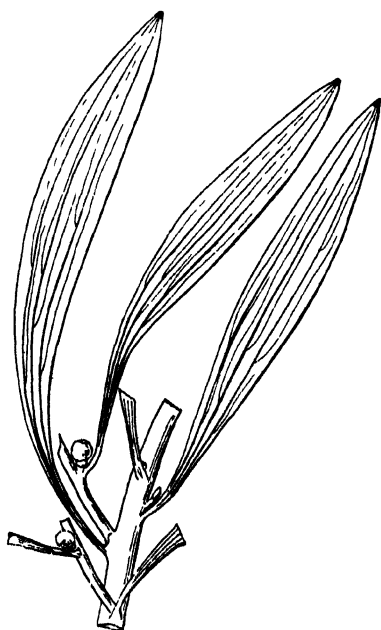


Fig. 3.—*Hakea laurina*.



Fig. 4.—*Hakea elliptica*.

4. *H. multilineata* Meissn.

A shrub or small tree resembling *H. laurina*: leaves narrow and 6 to 8 in. long, or broader and only 3 to 5 in. long, striate with numerous parallel nerves: flower-clusters oblong, 1 to 3 in. long, sessile in the leaf-axils, carmine in the center, fading to pale pink at the tips of the styles: capsule ovoid-globular with a very short beak, about $\frac{1}{2}$ in. broad. Illustration: *Gard. Chron.*, ser. 3, xix, fig. 14 (var.).

This has been reported from California gardens but all of the specimens seen were found to be *H. laurina*.

5. *H. elliptica* R. Br.

A neat erect shrub 6 to 10 ft. high: old herbage pale and glabrous but young twigs and leaves bronzed with a rich rusty pubescence: leaves oval or elliptic, obtuse or with a small callous point, nearly or quite sessile, 2 to $3\frac{1}{2}$ in. long, 1 to $1\frac{1}{4}$ in. wide, wavy-margined; the 5 to 7 parallel veins conspicuous on both sides and connected by numerous veinlets (reticulate): flower-clusters globose, sessile in the leaf-axils: capsule ovoid, with a stout oblique beak, 1 to $1\frac{1}{4}$ in. long, $\frac{3}{4}$ in. broad, usually smooth. Illustration: Fig. 4.

This is the best sort so far tried for general lawn and shrubbery planting, because of its sturdy growth, compact habit, and especially on account of the beauty of its young foliage. The rich bronze color of the young shoots is equalled, so far as I know, only in certain rare species of *Roupala* (see p. 44).

6. *H. undulata* R. Br.

An erect shrub 6 to 8 ft. high: young shoots rusty-tomentose, the adult foliage glabrous: leaves obovate, oblong, or rarely lanceolate, obtuse, tapering to a conspicuous petiole, 2 to 4 in. long, the margins wavy and sharply toothed; parallel nerves 3 or 5, connected by many cross veinlets: flowers in sessile clusters: capsule recurved at the base, distinctly beaked, 1 to $1\frac{1}{4}$ in. long, $\frac{1}{2}$ to $\frac{3}{4}$ in. broad, rather rough. Illustrations: Fig. 5; Hooker, *Icon.*, pl. 447.

Reported from California but I know of no specimens growing in the state.

7. *H. ulicina* R. Br.

A tall shrub with erect branches and dense foliage not unlike that of the Furze, or Gorse: twigs reddish, usually pubescent when young: leaves (glabrous at maturity) all narrowly linear, flat, acute and sharp-pointed, entire, varying in length from 1 to 8 in., very rarely over $\frac{1}{2}$ in. wide, prominently 1- to 3-nerved underneath: flowers very small, the pedicels and corolla glabrous: capsule rarely over $\frac{1}{2}$ in. long, with a short straight beak. Illustration: Fig. 6.

Perhaps not yet grown in California.

8. *H. suaveolens* R. Br. *H. pectinata* Colla.

A dense rounded shrub becoming 8 to 10 ft. high in California: young shoots and foliage silky pubescent but glabrous at maturity: leaves 2 to 4 in. long, about $\frac{1}{16}$ in. thick, cylindric, with a rigid spine-like tip, narrowly grooved on the upper side, occasionally entire but usually branched into 1 to 5 rigid cylindric lobes of various lengths: pedicels and perianth glabrous: flowers white, fragrant: capsule ovoid, about 1 in. long and $\frac{3}{4}$ in. broad, narrowed at apex and with a small conical horn near the end of one or both the valves. Illustration: Fig. 7.

This is perhaps the most common of all the cultivated Hakeas. It is easily grown, endures drought, and, by means of its spiny



Fig. 5.—*Hakea undulata*.

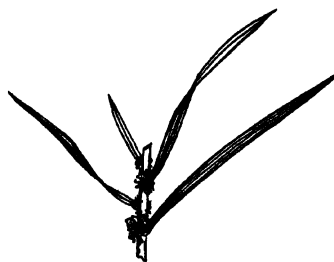


Fig. 6.—*Hakea ulcina*.

foliage, resists the depredations of animals and vandals. For public parks, depot grounds, and the like, no shrub could be selected which would be better able to care for itself, and it is eminently adapted to planting where an impenetrable hedge is desired. In the vicinity of Santa Barbara, it grows without care or irrigation on the dry hillsides and would undoubtedly make an excellent chaparral covering for many of our mountain slopes.

9. *H. acicularis* R. Br.

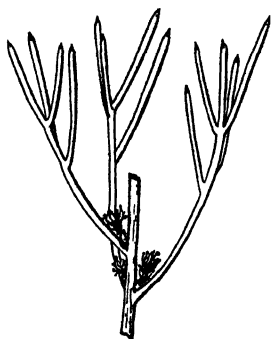
A tall shrub or (in Australia) a small bushy tree: twigs and young leaves sometimes minutely pubescent, glabrous when mature: leaves very slenderly cylindric, rigid, awl-like at the sharp tip, entire and simple, not grooved, mostly about 2 in. long (1 to 3 in.): pedicels silky-pubescent: corolla glabrous: capsule ovoid, about 1 in. long and $\frac{1}{2}$ in. or rather more broad, rough, contracted to a thick beak, each valve with a conic brown horn near the apex.

Suitable for hedges and for shrubberies. More slender than *H. suaveolens*.

10. *H. gibbosa* Cav.

A broad shrub, becoming 6 to 8 ft. high: twigs and young leaves hirsute with short spreading hairs: leaves cylindric, rigid, smooth, simple and entire, sharply pointed, 1 to 3 in. long: pedicels densely pubescent: corolla glabrous: capsule ovoid, oblique, about $1\frac{1}{2}$ in. long, nearly 1 in. broad, rough, abruptly contracted to a short oblique beak, each valve with a small dorsal horn near the apex. Illustrations: Fig. 8; Cav., *Icon.*, pl. 534; *Bot. Cook's First Voy.*, pl. 266.

Grown on the University grounds at Berkeley, a specimen determined by Dr. J. H. Maiden. Probably also elsewhere in the state but under erroneous names. More slender than *H. suaveolens* and better suited to small private grounds; almost equally as resistant to abuse, and should be tried with that species in reforestation experiments.

Fig. 7.—*Hakea suaveolens*.Fig. 8.—*Hakea gibbosa*.11. *H. pugioniformis* Cav.

A shrub with the habit, foliage, and general characters of *H. gibbosa*, from which it differs as follows: Corolla pubescent: style long, the disk nearly straight: capsule much more slender, lanceolate, acuminate, about 1 in. long and $\frac{1}{4}$ in. broad, rough around the middle with an obliquely transverse prominent crest, each valve tapering to a slender point. Illustrations: Cav., *Icon.*, pl. 533; *Bot. Cook's First Voy.*, pl. 265.

Grown at Santa Barbara, according to Dr. Franceschi, who says that it is an odd plant, which at a distance looks like a small pine. Some plants found under this name in the trade belong to *H. suaveolens*, a species easily distinguished by the mostly branched leaves and much thicker capsules.

THE BOTTLE-BRUSH GROUP OF ORNAMENTALS.

Bottle-brushes are eminently adapted to shrubbery and ornamental planting in California. They are rapid growers, hardy, endure considerable drought and abuse, and many of them are among the most showy of our cultivated shrubs.

It has been found, however, that the best sorts are not the ones most generally grown and that selection must be made with regard to the surrounding vegetation and to the particular needs. It is also to be remembered that what at first appears to be an undesirable form may become one of the best if given proper treatment, especially as regards pruning. It is hoped that the following notes will be of some assistance in these matters, but the chief aim has been to give an account whereby the different species may be determined. There is perhaps no group of ornamentals, generally planted in California, in which there is a greater confusion as to names, and the current horticultural publications are of but little assistance.

The most elaborate account of this group is to be found in Bentham's *Flora Australiensis*, and this work has formed the basis for my own determinations, aided by more recent scattered papers, a comparison of herbarium specimens from Australia, and certain critical notes very kindly supplied by Dr. J. H. Maiden, the Government Botanist of New South Wales.

The members of the Bottle-brush group are mostly Australian trees and shrubs belonging to the Myrtle Family (Myrtaceae), which may be characterized as follows:

Botanical Description of the Myrtaceae.

Leaves simple, entire, containing oil or resins which are mostly fragrant and commonly give a dotted appearance to the leaf: calyx tube adnate to the ovary, 4- or 5-toothed, or the teeth wanting: petals as many as the calyx-teeth, sometimes wanting, sometimes united into a cap and falling away together: stamens numerous, attached to a disk lining the calyx-tube and above the ovary: style simple, with a small round or flat stigma: ovary inferior, mostly 2- to several-celled, maturing into a capsule which is adnate to the calyx-tube (as a matter of convenience the term *capsule* is here used as including both the capsule proper and the enclosing persistent calyx-tube, the whole constituting the botanical "fruit"): ovules commonly numerous but the fertile seeds often few.

In addition to the Bottle-brush group there are a number of related genera, all members of the Myrtle Family, more or less common in cultivation. Such are the Eucalypti, of which something like 100 species are now grown in California. There is also a genus, *Angophora*, distinguished from *Eucalyptus* by the five small calyx-teeth and colored petals. *Angophora lanceolata* and *A. intermedia*, both with ribbed, turbinate capsules, are grown here. The former is a tree with smooth, deciduous bark, the latter is a tree with rough, persistent bark. *Syncarpia laurifolia* is sometimes mistaken for *Eucalyptus* but has distinct petals and the fruits are fused into a small head.

Tristania conferta is a related tree resembling our native Madroñe in general habit. It has conspicuous flowers with five petals each and the stamens united into bundles. The Australian Brush Cherry (*Eugenia*), with fleshy, edible fruits, is also a member of the Myrtaceae. *Kunzea* is a genus of slender heath-like shrubs with small leaves, belonging to this family but seldom seen in cultivation.

Six other genera, all natives of Australia and surrounding regions, are of especial interest in California gardens and parks. These constitute what may be considered the Bottle-brush group and may be distinguished by the following key:

Key to the Genera.

Anthers attached by the middle (leaves various: stamens either united or distinct).

Flowers in spikes or heads or solitary in the leaf-axils.

Stamens much longer than the petals: flowers in dense clusters.

Filaments not united or only slightly united at the very base *Callistemon* (p. 22).

Filaments united into 5 clusters *Melaleuca* (p. 27).

Stamens shorter than the petals.

Leaves not 1 in. long: flowers not in close heads, white *Leptospermum* (p. 35).

Leaves 2 to 6 in. long: flowers in small close heads, white *Agonis* (p. 36).

Flowers in loose terminal cymes *Metrosideros* (p. 36).

Anthers attached by the base: leaves terete, punctate: stamens red, united *Calothamnus* (p. 37).

CALLISTEMON.

The name *Bottle-brush* is particularly applicable to this genus of shrubs, the flowers being arranged in dense cylindrical spikes

in which the protruding stamens correspond to the bristles of a brush the handle of which is represented by the woody stem. "Chimney-sweep" is another suggestive appellation sometimes used.

Callistemons are favorites in California gardens and deserve to be even better known. They are perfectly hardy with us, endure considerable drought, and take kindly to pruning. In fact, severe autumn pruning is essential if masses of winter and spring bloom are desired. By this means the shrubs may be kept down to almost any desired size, while with but little pruning they may be allowed to occupy large corners or used as border shrubs for wide driveways. They are especially recommended for parks, depot-grounds, schoolyards, cemeteries, and for large private grounds; also for smaller yards, if used in moderation and kept well pruned. *C. brachyandrus* differs from the other species in being suitable for small grounds and is one of the very good shrubs that is little known. It is especially serviceable in adding grace and airiness to an otherwise somber yard.

The propagation of Bottle-brushes is not difficult. Seed is formed in abundance and although only a small percentage may be fertile there is seldom difficulty in getting a good stand. But seedlings are slow in reaching the flowering stage and because of this cuttings are commonly used. These should be taken in spring from ripened wood or at least from wood which is getting firm at the base. Three or four inches is about the proper length and propagation is best effected in sand under glass.

The identification of our garden forms is no easy task, since there are several apparent hybrids to be taken into account, as well as numerous cultivated forms. It is also to be remembered that among nurserymen this genus is occasionally united with *Metrosideros*, a union which the botanist cannot countenance. Since, however, the species names under *Metrosideros* are but seldom correctly applied, it would be as well for all interested to familiarize themselves with the proper names under *Callistemon*.

Key to the Species of *Callistemon* grown in California.**A. Stamens $\frac{3}{4}$ to 1 in. long.**Leaves lanceolate or oblong (mostly $\frac{1}{4}$ in. or more wide).Spikes rather loose: leaves with prominent midrib and lateral nerves 1. *C. lanceolatus*.Spikes very dense, more highly colored: leaves thicker and lateral nerves obscure 2. *C. speciosus*.Leaves linear (less than $\frac{1}{4}$ in. wide).Leaves flat, with prominent midrib, feather-veined.....3. *C. rigidus*.Leaves channeled above, midrib and lateral veins obscure 4. *C. linearis*.**B. Stamens $\frac{1}{2}$ in. or less long.**Leaves flat: stamens pale 5. *C. salignus*.Leaves cylindric: stamens bright red, with yellow anthers 6. *C. brachyandrus*.Fig. 9.—*Callistemon lanceolatus*.Fig. 10.—*Callistemon speciosus*.**1. *C. lanceolatus* DC. *Metrosideros semperflorens* Lodd.**

A tall shrub with erect or spreading but seldom curved branches: leaves lanceolate, $1\frac{1}{4}$ to $2\frac{1}{2}$ in. long, about $\frac{1}{4}$ in. wide, sharp-pointed, midvein and lateral nerves prominent: flower-clusters 2 to 4 in. long, not so dense as in the next species, bright red (rarely smaller and pale): stamens mostly 1 in. long: capsule ovoid, contracted at the summit. Illustrations: Fig. 9; *Bot. Mag.*, pl. 260; *Cav. Icon.*, pl. 332; *Bailey*, fig. 320; *Bot. Cook's First Voy.*, pl. 108; *Maiden, Fl. Pl. and Ferns of N. S. W.*, pl. 8.

This Bottle-brush is one of the most showy and has entered into several of the garden hybrids. Although not so stiff and rangy as *C. rigidus*, it requires severe pruning if a compact, densely flowered shrub is desired. Seldom becomes more than

8 feet high in California but reaches 30 feet and a trunk diameter of 18 inches in Australia, where the hard and heavy wood is used for wheelwrights' work and many implements, such as mallets.

2. *C. speciosus* DC.

A large shrub or becoming a fair-sized tree: leaves narrowly lanceolate, either obtuse or acute, $1\frac{1}{2}$ to 4 in. long, about $\frac{1}{4}$ in. broad, with prominent midrib as in *C. lanceolatus* but the leaf thicker and the lateral veins obscure: flowers highly colored, bright red, in very dense clusters (sometimes 6 in. long in Australia, much shorter with us): stamens 1 in. long: capsule nearly globose, the summit truncate and but little contracted. Illustrations: Fig. 10; pl. 2; *Bot. Mag.*, pl. 1761; Nicholson, vol. 1, fig. 327.

This is the most highly colored of all the *Callistemons*, the yellow or golden anthers contrasting finely with the dark-red filaments. With but little training it forms a graceful shrub with many drooping branchlets, eventually becoming a tree under favorable conditions. One specimen in Santa Barbara, now about 20 years old, is 35 or 40 feet high, and receives no care or irrigation. It has two blooming periods, the best being in December and January, but the second (May-June) again covers the tree with gorgeous balls of color suspended on slender pendant twigs. Numerous named cultural forms are derivatives of *C. speciosus*, the differences lying in varying shades of color, habit, and size.

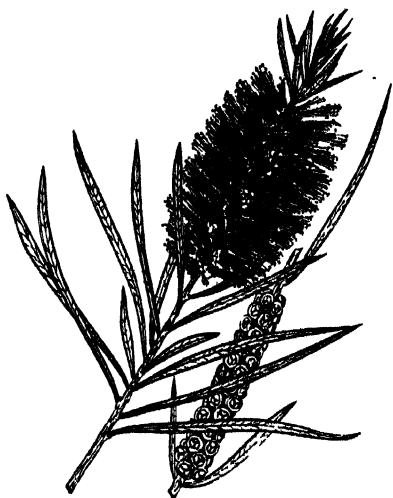
3. *C. rigidus* R. Br. *C. linearifolius* DC.

A stiffly branched shrub, the branches inclined to be longitudinal or spreading: leaves narrowly linear, rigid, sharp-pointed, 2 to 5 in. long, about $\frac{3}{8}$ in. wide, midrib and marginal ribs prominent, cross nerves spreading nearly at right angles or hidden by numerous oil-dots: flower-clusters deep red, large (rarely small and pale): stamens 1 in. or more long. Illustrations: Fig. 11; *Bot. Reg.*, pl. 393; *Bot. Cook's First Voy.*, pl. 109.

Perhaps the most common form in California. Begins to bloom when only a foot or two high, and if left to itself becomes an ungainly sprawling shrub. Should be frequently pruned up when young and headed in when older. In this way a round-topped, compact, densely flowered shrub 6 to 10 feet high may be obtained.

4. *C. linearis* DC.

Scarcely more than a variety of *C. rigidus*, being the extreme form with very narrow leaves which are channeled above, and the midvein quite obscure; fruiting calyx more globular and more contracted at the opening.

Fig. 11.—*Callistemon rigidus*.Fig. 12.—*Callistemon salignus*.5. *C. salignus* DC.

A tall shrub or small tree (6 to 10 ft. high, in Australia reaching 40 or 50 ft.): leaves broadly to narrowly lanceolate, very acute, $1\frac{1}{2}$ to 3 in. long, mostly $\frac{1}{4}$ to $\frac{3}{4}$ in. wide, but much narrower in one variety, very distinctly feather-veined: flower-clusters pale yellow or light pink, 1 to 2 in. long, $\frac{1}{4}$ to 1 in. wide: stamens $\frac{1}{4}$ to $\frac{1}{2}$ in. long: capsule nearly globular, with rather large opening. Illustration: *Bot. Mag.*, pl. 1821. Var. *viridiflorus* F. Muell. has leaves only 1 to 2 in. long, thicker, the veins obscure, rigid and sharp-pointed: flowers larger, greenish yellow: habit more erect, rigid, and tree-like. Illustrations: Fig. 12; *Bot. Mag.*, pl. 2602.

Rare in California gardens and not especially desirable. The wood, which is very hard and close-grained, is said to be very durable underground and to dress admirably. It varies from a uniform drab color to dark red.

6. *C. brachyandrus* Lindl.

A slenderly branched shrub, the young shoots softly hairy, the hairs sometimes persistent and giving the whole shrub a soft gray tone: leaves rigid, terete, or slightly flattened or channeled, sharp-pointed, $\frac{3}{4}$ to $1\frac{1}{2}$ in. long: flower-cluster 2 or 3 in. long, $1\frac{1}{4}$ in. wide: stamens about $\frac{1}{4}$ in. long, the deep red filaments nearly obscured by the golden-yellow anthers. Illustration: Fig. 13.



Fig. 13.

Callistemon brachyandrus.

Rare with us but very desirable, the combination of the slender twigs, gray foliage, and golden bloom, being a novelty among Bottle-brushes. Requires frequent heading in for best results.

MELALEUCA.

This genus of about 100 species includes a majority of the so-called tea-trees of Australia and many of the shrubs known in California as Bottle-brushes. The flowers are often arranged as in *Callistemon*, which may be considered the true bottle-brush genus, but the clusters are not so large and showy, except in one species, *Melaleuca hypericifolia*. But if *Melaleuca* lags behind *Callistemon* in the matter of brilliant coloring, the various species exhibit more grace and symmetry of outline, and the available species are now so numerous that one or more sorts may be selected for almost any situation.

All of the species here considered are suitable for nearly any locality in California, being hardy, except in the mountainous districts, and capable of withstanding at least moderate drought. It must be remembered, however, that the arboreal species will seldom develop into more than fair-sized shrubs unless given attention and occasional irrigation, and that a combination of warm summers and a moist soil are essential to the luxuriant development sometimes described. So far as I know, no *Melaleuca* has yet been killed by frost in California.

For ordinary yard planting the best kinds are *M. lateritia* and *M. armillaris*, the former with brick-red flowers, the latter

slender twigs and very narrow leaves. *M. hypericifolia* is more spreading than either of these, has recurved branches, brilliant red flowers in large clusters, broad leaves, and never attains a great height. For formal planting *M. linariifolia* will be found more suitable, the branches being more nearly erect, more rigid, and with straight firm leaves of a light-green color. *M. styphe- lioides* and *M. Huegelii* are also formal in their effect and are of a darker green.

Of the arboreous species, *M. leucadendron* is in the lead and is perhaps the only one to be considered for avenue planting. *M. armillaris* grows sufficiently high, at least in the south and when left unpruned, to make a shade for arbors and walks. *M. nesophila* and *M. ericifolia* are also tree-like, the former being especially good where a mass of ordinary foliage is desired.

As a chaparral covering for our foothills, *M. nesophila*, *M. decussata*, and *M. styphe lioides* are recommended.

Members of this genus are more resistant to alkali than are most plants. In Australia *M. ericifolia* and other species are used for fixing muddy shores where the water is strongly saline and *M. leucadendron* is planted in salt swamps where no Eucalypt will live, being protected by its thick, corky bark. The thick-barked *M. nesophila* and *M. styphe lioides* could also be used in these situations, the former being the most promising because of its great hardiness and rapidity of growth. Seedlings should never be transplanted to saline soil until they have developed a good root system and are protected by well-formed bark.

The methods of propagation are the same as given for Callistemons.

Key to the Species of Melaleuca grown in California.

A. Inflorescence a cylindric spike.

Flowers red or scarlet: stamens $\frac{3}{4}$ in. or more long (except in no. 4).

Leaves opposite: stamen-claw very long.

Midrib prominent; leaves $\frac{1}{6}$ to $\frac{1}{2}$ in. wide 1. *M. hypericifolia*.

Midrib obscure; leaves linear 2. *M. fulgens*.

Leaves alternate, narrow.

Stamens about $\frac{3}{4}$ in. long, the claws very short: leaves obscurely 1-nerved or nerveless 3. *M. lateritia*.

Stamens about $\frac{1}{4}$ in. long: upper leaves striate with 7 or more nerves 4. *M. genistifolia*.

Flowers white, blue, lilac, or pink: stamens under $\frac{1}{2}$ in.

Leaves mostly opposite.

Calyx ovoid (the base somewhat narrowed): leaves linear, 1 in. or more long 5. *M. linearifolia*.

Calyx with broad base partly embedded in the stems at maturity: leaves linear, $\frac{1}{4}$ to $\frac{1}{2}$ in. long 6. *M. decussata*.

Leaves mostly alternate or spiral.

Length of leaves mostly exceeding $\frac{1}{2}$ in.

Nerves several and the leaves somewhat striate.

Leaves elliptic to oblong, 2 to 4 in. long ...7. *M. leucadendron*.

Leaves ovate or lanceolate, sharp-pointed, less than 1 in. long 8. *M. styphelioides*.

Nerves solitary or obscure, the leaves very narrow and slender 9. *M. armillaris*.

Length of leaves mostly $\frac{1}{2}$ in. or less.

Calyx narrowed at base (ovoid): leaves linear, rigid, straight, about $\frac{1}{2}$ in. long 10. *M. parviflora*.

Calyx with broad flat base, partly embedded in stem at maturity.

Leaves ovate with broad base, rigid, scale-like, $\frac{1}{4}$ in. or less long 11. *M. Huegelii*.

Leaves linear, slender, curved 12. *M. ericifolia*.

B. Inflorescence a terminal globular head, the axis not growing out until after flowering (except in no. 16).

Stems and leaves glabrous or nearly so.

Flowers pink.

Leaves $\frac{1}{4}$ in. or more wide: capsules in a globose head 13. *M. nesophila*.

Leaves $\frac{1}{4}$ in. or less wide: capsules in a cylindric spike or scattered 6. *M. decussata*.

Flowers white or yellowish.

Leaves rigid, straight, sharp-pointed 14. *M. nodosa*.

Leaves lax, curved, scarcely acute 12. *M. ericifolia*.

Stems or leaves white with a close tomentum.

Leaves about $\frac{1}{4}$ in. long 15. *M. incana*.

Leaves minute (less than $\frac{1}{16}$ in.), scale-like 16. *M. micromeria*.

1. *M. hypericifolia* Sm.

A tall glabrous shrub: leaves opposite, lanceolate elliptic or narrowly oblong, acute or obtuse, $\frac{3}{4}$ to $1\frac{3}{4}$ in. long, $\frac{1}{6}$ to over $\frac{1}{2}$ in. wide, the midrib and numerous dots prominent beneath: flowering spikes of a rich red, 2 in. long and of the same diameter, forming the bases of leafy branches: stamens $\frac{3}{4}$ to 1 in. long, the claw about $\frac{1}{2}$ in. long and splitting into about 20 filaments: capsule sessile by a broad base: seeds numerous. Illustration: Pl. 3, fig. 1.

One of the most showy species and very popular both for its gorgeous bloom and for the pleasing foliage. Easily mistaken for a *Hypericum* when not in flower.

2. *M. fulgens* R. Br.

A tall shrub, glabrous throughout: epidermis of the bark peeling off in strips: leaves mostly opposite, from very narrowly linear to narrowly lanceolate, acute or obtuse, $\frac{1}{2}$ to 1 in. long, the midrib very obscure, usually dark-dotted: flowering spikes of a rich dark red, rather loose and few-flowered: stamens often 1 in. or more long, the ribbon-like claw splitting into numerous filaments: capsule cup-shaped, sessile. Illustrations: Pl. 3, fig. 4; *Bot. Reg.*, pl. 103.

Perhaps not grown in California but long known in European gardens and certain to be introduced here.

3. *M. lateritia* Otto.

A graceful shrub with numerous slender branches, 6 to 10 ft. high: bark soft and corky, becoming fibrous: leaves alternate, overlapping, narrowly linear, acute, $\frac{1}{2}$ to $\frac{3}{4}$ in. long, $\frac{1}{10}$ in. wide, apparently nerveless: flowering spikes of a rich scarlet color, cylindric, about $2\frac{1}{2}$ in. long and $1\frac{1}{2}$ to $1\frac{3}{4}$ in. in diameter, forming the base of leafy branches: stamens $\frac{3}{4}$ in. long, very shortly united into clusters of 7 to 11 each: capsule with broad base somewhat embedded in the stem. Illustration: Pl. 3, fig. 2.

This is one of the most graceful of all the *Melaleucas* and with a much more pleasing color than any of the other red-flowered species, the shade being softer and not so harsh. Little known. Good examples may be seen at Elysian Park, Los Angeles, and at Soldiers Home.

4. *M. genistifolia* Sm.

A tall shrub (attaining 40 ft. in Australia), either glabrous or somewhat pubescent: leaves alternate, lanceolate or linear-lanceolate, rigid, acute, usually about $\frac{1}{2}$ in. long, finely striate (at least the upper ones) with 7 or more nerves: flowering spikes loose, often leafy, and the axis usually growing out before the flowers expand: stamens about $\frac{1}{4}$ in. long, each claw with numerous filaments: capsule nearly globular, crowned by the persistent teeth.

Reported from California but not seen by me. In Australia a tea is made from the leaves.

5. *M. linariifolia* Sm.

A tall shrub (a large tree in Australia), the young parts a little pubescent, adult foliage glabrous and pale green: bark soft, shedding in large flakes: leaves opposite, rigid, linear, tapering to a sharp point, mostly 1 to $1\frac{1}{4}$ in. long, $\frac{1}{8}$ in. wide, the midrib prominent beneath:

flowers white (or lilac?), in pairs (this especially distinct in bud), in dense spikes of 1 to 1½ in. in length, these at first terminal but the axis finally grows out into a leafy branch: stamens ½ to ¾ in. long, the long claws emitting short filaments along their entire length: capsule ovoid-globular, narrowed at base. Illustrations: Pl. 3, fig. 3; Cav., *Icon.*, pl. 336 (poor).

Flourishes at Berkeley and at Los Angeles. A rare sort which should be widely cultivated for its trim habit, pale foliage, and usually pure-white flowers.

6. *M. decussata* R. Br.

A large spreading shrub, sometimes 20 ft. high, the branches commonly pendulous: bark shreddy: herbage bright green and glabrous throughout: leaves strictly opposite, elliptic oblong or lanceolate, acute or obtuse, narrowed to the base, ¼ to ½ in. long, nearly ⅓ in. wide: flowers lilac, the buds strictly opposite, the clusters cylindric, 1 in. or less long, the axis growing out as a leafy shoot, or the clusters globose and terminal or lateral when the flowers are sterile: stamens ¼ in. long, shortly united into bundles of 10 to 15 each: capsule partially embedded in the woody stem. Illustrations: Pl. 4, fig. 1; *Bot. Mag.*, pl. 2268.

Common in California gardens but suitable only for large grounds and parks.

7. *M. leucadendron* L. *M. cajuputi* Roxb. CAJUPUT TREE. PUNK TREE.

A large tree with thick spongy bark which peels off in layers, and pendulous branchlets, either entirely glabrous or the young shoots silky: leaves alternate, elliptic or oblong, tapering to each end, usually 2 to 4 in. long (rarely even 8 in.) and ½ to ¾ in. wide, with 3 to 7 parallel nerves and numerous cross veinlets: flowering spikes creamy white (varying to pink and purple in Australia), 1½ to 4 in. long, 1 in. wide, at first terminal, the axis growing out only after flowering: stamens nearly ½ in. long. Illustrations: Pl. 4, fig. 3; Cav. *Icon.*, pl. 333 (as *Metrosideros quinquenervia*); Maiden, *Forest Fl. N. S. W.*, pl. 15; *Bot. Cook's First Voy.*, pl. 112.

This tree, which resembles some of the Acacias, is grown sparingly in Southern California. The largest specimen (about 20 years old) is at the Coronado Nurseries and measures 40 feet in height, the trunk is 14 inches in diameter, and the soft bark ¾ to 1½ inches thick. The wood is said to possess "a most beautiful combination of light and darker shades, which may be compared in appearance to ripple marks" (Maiden), and to be hard, heavy, close-grained, and imperishable underground. The

tree withstands the effect of salt water by means of its thick, impervious bark. The leaves of certain forms yield cajuput oil, an article of commerce used in medicine.

8. *M. styphelioides* Sm.

Becoming a tall tree, with thick spongy bark; young shoots and inflorescence silky, the herbage otherwise glabrous: leaves alternate, ovate, sessile by a broad base, tapering above to a sharp rigid tip, usually more or less twisted, $\frac{5}{8}$ in. long, nearly $\frac{1}{4}$ in. wide, striate with numerous fine nerves: flower-clusters creamy-white, dense, 1 or 2 in. long, nearly 1 in. wide, the axis growing out before flowering is over: stamens slightly exceeding $\frac{1}{4}$ in. in length: capsule globular, crowned by the persistent calyx-teeth. Illustration: Pl. 4, fig. 4.

Cultivated, so far as I know, only around San Diego but should be more generally used. The largest specimens are now large shrubs of neat appearance and with much clean, thrifty growth.

9. *M. armillaris* Sm.

A tall shrub, of graceful habit, glabrous throughout: bark gray, firm, furrowed, deciduous in narrow strips: leaves densely clothing the long slender twigs, alternate, narrowly linear, the tip very slender and usually curved outward, $\frac{1}{2}$ to $\frac{3}{4}$ in. long, less than $\frac{1}{16}$ in. wide: flower-clusters white, cylindric, over 2 in. long when well developed, $\frac{3}{4}$ in. wide, the axis protruding and leafy before the buds open: stamens $\frac{1}{4}$ in. long, the ribbon-like claw about as long as the free filaments: capsule with broad base partly embedded in the stem. Illustrations: Pl. 4, fig. 2; pl. 6; ('av. *Icon.*, pl. 335 (bad); *Bot. Cook's First Voy.*, p. 114.

This I consider the best of the white-flowered sorts. Especially suited to shrubberies and borders of broad walks where something graceful is desired. By means of a little heading in it may be made to assume a rounded form with many slender, drooping branchlets, each densely clothed with the abundant narrow foliage. This absence of barren twigs and of knotted fruit-clusters is one of its chief advantages. Specimens have grown to a height of 7 feet in two years at Santa Barbara, while shrubs 20 years old at Coronado are only 15 feet high. Much used at West Lake Park, Los Angeles, often as a shelter for the park benches. Does fully as well at San Mateo, San Francisco, etc., but perhaps of slower growth. Said to attain 20 to 30 feet in Australia. Often called *M. alba* in California gardens.

10. *M. parviflora* Lindl. *M. Preissiana* Schau.

A tree or tall shrub, glabrous or the young parts pubescent: leaves alternate, thick, rigid, lanceolate or oblong-linear, sharp-pointed, $\frac{1}{2}$ in. long or rather less, obscurely if at all nerved: flower-clusters white, loose, 1 in. or less long, capsule globose (narrowed to the base). Illustration: Pl. 5, fig. 1.

A hardy shrub, grown both in central and southern California, but much surpassed, as regards beauty, by other species. *M. armillaris* and *M. ericifolia* are often erroneously labeled *M. Preissiana* in California gardens; but this last name is only a synonym of *M. parviflora*.

11. *M. Huegelii* Endl.

An erect rigid shrub, 6 to 12 ft. high, with firm, pale bark, nearly glabrous: leaves alternate, spirally arranged and overlapping, strictly sessile, ovate, contracted above to a sharp point, $\frac{1}{4}$ in. or less long, striate with 3 to 7 nerves: flower-clusters white (the buds sometimes pink), dense, 1 to 5 in. long, about $\frac{3}{4}$ in. wide, the axis growing out before the buds open: stamens $\frac{3}{8}$ in. long, the claw conspicuous and divided at the end into 7 to 11 filaments: capsules globular, crowded in a cylindric spike. Illustration: Pl. 5, fig. 5.

Frequent in southern California shrubberies where valuable chiefly because of its oddity. At Soldiers Home many of the branches fasciate, forming flat, leafy ribbons.

12. *M. ericifolia* Sm.

A large shrub or small tree, either glabrous or pubescent, the bark thick and soft: leaves alternate, not rigid, usually recurved from the middle, narrowly linear or nearly cylindric, rather obtuse, about $\frac{1}{2}$ in. long: flowering spikes yellowish-white (there is a roseate variety in Australia), $\frac{1}{2}$ to 1 in. long and $\frac{3}{8}$ in. wide, the rachis soon growing out and leafy, or the flowers sometimes in nearly globular terminal heads (staminate): stamens $\frac{1}{4}$ in. long, the claws conspicuous and with about 7 filaments at the end: capsules truncate, in a dense spike. Illustration: Pl. 5, fig. 3.

A slender shrub resembling heath (*Erica*). Not much used in California. A few arboreous specimens may be seen on the lawns near the conservatory of Golden Gate Park, San Francisco.

13. *M. nesophila* F. Muell.

A glabrous shrub or small tree, attaining 35 ft. in California, with thick spongy bark which exfoliates in broad strips: leaves alternate, obovate-oblong, obtuse or with a sharp tip, thick, $\frac{1}{2}$ to 1 in. long, about

$\frac{1}{4}$ in. wide, obscurely 1- or 3-nerved: flowers pink or rose-color, in dense terminal heads 1 in. or more in diameter, the axis seldom growing out before flowering is over: claw of the stamens short: capsules smooth, congested in a globose or ovoid mass. Illustration: Pl. 5, fig. 4.

Suitable for parks and other large grounds. A very rapid grower and makes a fair shade, but the capsules, which form knot-like excrescences on the exposed branches, are objectionable.

14. *M. nodosa* Sm.

A tall nearly glabrous shrub: leaves linear or subulate, rigid, straight and rigidly sharp-pointed, $\frac{1}{2}$ to $\frac{3}{4}$ or 1 in. long: flowers pale yellow, in numerous dense globular clusters which are scarcely $\frac{1}{2}$ in. in diameter, the axis not growing out until after flowering: capsules in small compact heads scarcely more than $\frac{1}{4}$ in. across. Illustrations: Pl. 5, fig. 2; Cav. *Icon.*, pl. 334; *Bot. Cook's First Voy.*, pl. 115.

Rare in cultivation. Grown in Golden Gate Park.

15. *M. incana* R. Br.

A tall shrub, the young twigs and flowering branches ashy with a fine close pubescence: leaves alternate or sometimes opposite, spreading, linear to lanceolate, acute, $\frac{1}{4}$ to $\frac{1}{2}$ in. long, hoary with white hairs at least when young, mostly 1-nerved: flowers yellowish white, in dense terminal ovoid or oblong spikes about $\frac{3}{4}$ in. wide, the axis rarely growing out until after flowering: stamens shortly united in bundles of 3 to 9: capsules in dense cylindrical spikes $\frac{3}{4}$ to 1 in. long. Illustrations: Fig. 14; *Bot. Reg.*, pl. 410.



Fig. 14.—*Melaleuca incana*. del Monte grounds, Monterey.

Reported as growing in Golden Gate Park. A beautiful specimen with pendant twigs may be seen in the "Arizona Garden," on the Hotel

16. *M. micromeria* Schau.

A tall shrub with many short slender branches, covered by a short close white tomentum which is often concealed by the minute foliage: leaves exceedingly minute, mostly in whorls of 3, closely appressed to the stem, ovate, scale-like: flowers in small globular heads about $\frac{1}{4}$ in. in diameter: capsules in dense clusters less than $\frac{1}{2}$ in. across.

Once grown at Santa Barbara by Dr. Franceschi but probably no longer in cultivation in California.

LEPTOSPERMUM.

This is a genus of shrubs and small trees, with small, entire, alternate leaves and mostly white flowers on short lateral branches. All of our species are from Australia except *L. ericoides*, which is a native of New Zealand, and *L. scoparium*, which occurs both in Australia and New Zealand.

The only one to be recommended for general planting is the well known *L. laevigatum*, the others being in no way superior and of value chiefly as novelties. This species, however, grows rapidly and soon makes a spreading shrub 8 to 12 feet high, which is laden during the spring months with a profusion of white bloom. It is particularly adapted to mass planting in large parks and for filling in unsightly corners. Because of its drought resistant properties and its rapid growth, it should be experimented with as a shrub for reforestation purposes in our foothill districts. In case a larger plant is desired, *L. fabricia* may be used, since it is reported as becoming quite arboreous in Australia. *L. flavescens* is much grown in Europe and its var. *grandiflorum* has flowers of the largest. *L. scoparium* is a shrub, rarely attaining 12 feet. When the leaves are exceedingly narrow it is called *L. juniperinum*. Its flowers are sometimes pink or even red. *L. ericoides* is one of the "tea trees" of New Zealand, sometimes growing to a height of 40 to 60 feet, with a trunk sufficiently large to be used for piling, fence posts, etc., and would probably grow without care on our lower hills.

Propagation is effected by use of the seeds although these are not always fertile. Cuttings from young wood are more satisfactory and are grown under glass. All of the species are hardy for California and endure drought well.

*Key to the cultivated Species of Leptospermum.***A. Ovary and capsule 6- to 10-celled: fertile seeds rather broadly winged.**

Calyx glabrous: leaves broad, obtuse, $\frac{1}{2}$ to 1 in. long: flowers large 1. *L. laevigatum* Muell.

Calyx villous: otherwise similar 2. *L. fabricia* Benth.

B. Ovary 5-celled: seeds linear.*Calyx glabrous.*

Leaves obtuse, $\frac{1}{4}$ to $\frac{3}{4}$ in. long: flowers of medium size 3. *L. flavescens* Sm.

Leaves acute, narrow.

Flowers $\frac{1}{2}$ to $\frac{3}{4}$ in. across: leaves with rigid tips
4. *L. scoparium* Forst.

Flowers $\frac{1}{4}$ in. across: leaves small, dense, heath-like, the tips not
 rigid 5. *L. ericoides* A. Rich.

Calyx pubescent with long hairs.

Calyx broad and obtuse at the base, villous with long hairs: leaves
 linear, or elliptic, or obovate, obtuse or with a short sharp tip
6. *L. lanigerum* Sm.

Calyx attenuate at the base (at least when young), silky with ap-
 pressed hairs: leaves small, obovate or oblong
7. *L. myrtifolium* Sieb.

Since only one or two species of *Leptospermum* are grown in California to any considerable extent, the detailed botanical descriptions are omitted.

AGONIS.

One species of *Agonis* is grown in California, namely *A. flexuosa* Schau., of which good examples may be seen in Golden Gate Park and at Soldiers Home, near Los Angeles. The shrub is commonly mistaken for a *Leptospermum* but is much more graceful in habit and with longer, more slender leaves. Very serviceable where a pendant effect is desired rather than a show of bloom.

METROSIDEROS.

This genus includes two magnificent New Zealand trees, grown in California to a limited extent. They may be known by their large size, the thick and leathery strictly opposite leaves, and the rounded, terminal flower-clusters rendered brilliant by the profusion of long-exserted, crimson stamens. In *M. robusta* A. Cunn. the leaves are glabrous and 1 to $1\frac{1}{2}$ inches long; in *M. tomentosa* A. Rich. they are usually clothed beneath with white hairs and are mostly 2 to 4 inches long.

Metrosideros may be used either as an ornamental shrub or as an avenue tree. It is easily propagated by means of cuttings since it is disposed to throw out roots, even on the main branches. In New Zealand "it commonly commences life as an epiphyte, in the upper branches of some tall forest tree, sending to the ground aerial roots which coalesce and form a trunk after the death of the supporting plant" (Cheeseman).

These trees are not hardy, and although grown at San Francisco will not endure a temperature much below the freezing point.

Several species of *Callistemon* are known in trade as *Metrosideros*. The so-called *M. semperflorens* and *M. latifolius* are mostly *Callistemon lanceolatus*. *M. speciosus* is *Callistemon speciosus*.

CALOTHAMNUS.

Although often confused with *Melaleuca*, this genus is at once distinguished by the anthers, which are erect and attached by the very base to the summit of the filament. Our only common species in cultivation is *C. quadrifidus* R. Br., of Australia, a low shrub with cylindric, punctate leaves and clustered crimson flowers with long stamens united into bundles. Its uses and methods of propagation are similar to those given for *Callistemon*.

MISCELLANEOUS ORNAMENTALS.

***Lyonothamnus floribundus* var. *asplenifolius* Brandegee.**

ISLAND IRONWOOD.

An erect, evergreen tree, becoming 75 ft. high, with very heavy and dark wood and a loose red bark which exfoliates in long ribbon like strips: leaves fern-like, opposite, stalked, mostly parted into several narrowly oblong or lanceolate segments, each segment 3 or 4 in. long and cut to near the midrib into many shield shaped lobes (mostly simple and nearly entire in typical *L. floribundus*), white-tomentose beneath or glabrous: flowers white, small, but the clusters dense and 4 to 8 in. across: sepals and petals 5 each: stamens 15: pistils 2, distinct: seeds usually 4, minute. Family Rosaceae. Santa Barbara Islands. Illustrations: Fig. 15; pl. 7; *Zoe*, i, pl. 5; Sudworth, *Forest Trees Pacif. Slope*, figs. 154, 155; Sargent, *Silva*, pl. 197; Sargent, *Man. Trees N. A.*, fig. 275.

Lyonothamnus is, in many respects, the most remarkable contribution that California has made to the world's list of ornamental trees. It is known native only on Santa Cruz, Santa Rosa, Santa Catalina, and San Clemente islands, and was first brought to the mainland in 1894 by Dr. Franceschi, of Santa Barbara. In that year one live stump and a quantity of seeds were procured on Santa Cruz Island. The former was planted on State street, Santa Barbara, where it produced a tree about

35 feet high in 16 years. Several plants were obtained from the seed. At least two of these (one on the Gillespie grounds, Montecito, one at the Cooper Ranch, Elwood) bloomed when 13 years old. Another tree of this same generation is growing vigorously on the University Campus at Berkeley and now, at 15 years of age, is in bloom for the first time. It measures 45

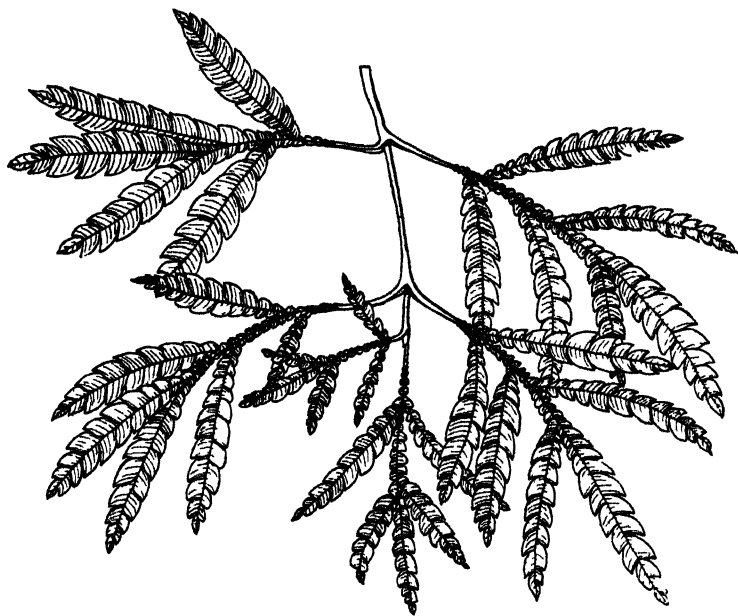


Fig. 15.—*Lyonothamnus floribundus*.

feet high, and has a trunk diameter of 10 inches. Because of its beauty and symmetry, as well as its botanical interest, it is justly considered the pride of the garden.

The ornamental uses which can be made of this tree are numerous. It harmonizes well with almost any combination of surroundings, but is not adapted to small grounds. The tall, stately habit adds dignity to any environment, while the dense and gracefully drooping foliage forbids any suggestion of rigidity or coldness, and when covered with the copious white bloom the tree is certainly a pleasing sight. As a specimen tree for large grounds, parks, and the like it is unexcelled, particularly

if plenty of room is given it, in order that there may be a symmetrical development and that the general outline may be brought out.

Lyonothamnus is especially recommended as an avenue tree. The erect habit of growth, moderate spread, and narrow crown, would combine with the graceful foliage in making an avenue of these trees one of the most dignified and pleasing drives in the state. It is hoped that the supply will soon be sufficiently adequate to warrant their utilization for this purpose.

Objection has been made to it as a lawn tree because of the litter produced, but healthy trees cast no appreciable amount of litter. When grown on lawns, the ground directly under the tree should be cultivated. The only further objection that I have heard is that it harbors black scale, this reason being given for its scarcity at Los Angeles. This objection, however, is not a serious one, since black scale is now readily held in check by certain animal parasites. Trees at Santa Barbara and at Berkeley are not infested with scale to any noticeable extent.

Concerning the conditions under which *Lyonothamnus* may be expected to thrive, we can only say that, so far as tried, there have been no failures. These trials have been mostly in the coast districts. The interior may be too dry for its best development, but this point has not yet been tested. Perhaps the best specimen in cultivation is the one on the Reed grounds at Pasadena, where the summers are quite warm and dry. Its hardiness is likewise unknown, but temperatures of 25° F. have not affected the foliage whatever.

In its natural habitat, *Lyonothamnus* grows on well drained soil which is moderately moist. The groves, so far as I have observed, are always on north slopes, but neither in cañon bottoms nor on the wind-swept ridges. These groves are of very limited size, mostly covering less than an acre of land, and of limited number. Seedlings, moreover, are entirely wanting, all of the trees being apparently second growth, that is, suckers from old stumps. Even where the old stumps are not found, the trees are frequently arranged in an irregular circle, the center of which was perhaps once occupied by the parent tree. Only a very small percentage of the seeds are fertile and nurserymen

who have propagated them have had much difficulty because of the readiness with which the young seedlings damped off. All of these facts, together with the isolation of the genus from all related forms, seem to indicate that we have here a decadent race, marooned on these few islands where its last stand in the fight for existence is being made.

That this race of trees will become extinct unless protected is a certainty. Steps should be taken, either by the State or Federal Government, to acquire and protect at least a few of the groves. An important factor in the weakening of this race is doubtless that of inbreeding. There are apparently no special devices for cross pollination and, judging from the botanical characters of the two forms, there is almost certainly no transfer of pollen from one island to another. If artificial cross pollination were practiced between the typical form and the var. *asplenifolius*, a good yield of fertile seed would probably result and give rise to a stronger race. At least, the experiment should be made.

Propagation is best effected by seed. These are largely infertile, so that only a small percentage can be expected to germinate. In the past, this seed has all come from Santa Cruz Island, but cultivated trees at Santa Barbara are now yielding a more convenient supply. In propagating from seed, great care must be exercised to see that the seedlings do not damp off in the early stages. Stumps have been successfully transplanted but their shipment from the islands is expensive. They may be divided by splitting, but experience has shown this to be a precarious proceeding. All attempts at layering and propagation by means of cuttings have failed up to the present time.

***Eugenia myrtifolia* Sims.²**

AUSTRALIAN BRUSH CHERRY.

An evergreen glabrous tree, or shrub-like: leaves opposite, oval or oblong, narrowed to each end, short-stalked, mostly acute, entire, $1\frac{1}{2}$ to 3 in. long: flowers in loose clusters: calyx-tube top-shaped, the lobes

² Some confusion has arisen because of the various names applied to this tree. *Eugenia australis* Wendl. is exactly the same, according to best authorities. *Jambos myrtifolia* Nadz. is the name adopted in Engler and Prantl's *Naturlichenpflanzenfamilien*.

unequal: petals 4, white, $\frac{1}{4}$ in. across: stamens numerous: ovary inferior: style single: fruit red, ovoid, nearly 1 in. long, fleshy, of a pleasing acid taste. Family Myrtaceae. Australia. Illustrations: Pl. 8; *Bot. Mag.*, pl. 2230.

This tree may be used as a hedge plant, as a shrub for the lawn or garden, as a specimen tree for large grounds, or as a street tree, and is perhaps the best of the whole list for general planting. The habit is dignified, yet graceful and pleasing. Its leaves are plentiful, clean, glossy, and green. It prunes well, and so may be molded to harmonize with its surroundings. *Eugenia* is hardy for all of the coast district of California, grows well as far north as Sacramento (and there is no reason why it should not be used much beyond this latitude), and in the interior at least as far as Redlands.

When it is desired to form a tall, narrow hedge, the plants should be set close together. If a shrub is desired, the growth of several central stems should be encouraged and the head cut back. Even so it will insist on becoming a tree in favorable localities, in which case it will be necessary to resort to root pruning.

Growth is not rapid, although one specimen at Coronado attained a height of 40 feet in 20 years. At Santa Barbara a tree 80 feet high was observed, but the age is not known. On the San Francisco Peninsula it is commonly grown in masses and therefore remains low. A good example, 20 feet high, may be seen on the Capitol grounds at Sacramento.

As a street tree, *Eugenia myrtifolia* would almost certainly be a splendid success. The difficulty of procuring a large supply of trees has prevented its use for this purpose, but they are now sufficiently plentiful to warrant its adoption for some of our more progressive cities.

Propagation is easily accomplished from seeds, but these are not to be had in large quantities. Cuttings taken from firm or partially ripened wood strike without difficulty.

Macadamia ternifolia F. Muell.

AUSTRALIAN NUT.

A slender glabrous tree, becoming 50 ft. high: leaves in whorls of 3 or 4, or the upper ones more scattered, oblong or lanceolate, acutish,

short-stalked or sessile, serrate with remote sharp slender teeth or entire, several inches to 1 ft. or more long: flowers small, in long racemes, growing in pairs on short stalks: ovary simple, developing into a hard-shelled ovoid nut with a leathery covering. Family Proteaceae. Australia.

Valuable chiefly because of its nuts, this tree also deserves consideration as an ornamental. It is a clean, straight-growing, pleasing tree, without objectionable features, and is suggested as a specimen tree for parks and large gardens and also as a nut tree, both for commercial plantations and for the home orchard.

Specimens are growing at San Francisco and Berkeley, but none of these have yet blossomed, so far as I am aware. This may be due to excessive shading or crowding or to unfavorable soil conditions. At Santa Barbara we find several splendid trees. One of these, now about five years old, is 15 feet high and bearing nuts, although it has had no attention. Another, on the Gillespie grounds at Montecito, is eleven years old and has borne several crops. This tree, although on poor soil and much crowded, is now about 50 feet high and still growing. Some of its branches are 10 feet long, the lower ones sweeping the ground, the shorter upper ones ascending, the whole appearance being that of a thrifty, well established specimen, a credit to any garden.

The flowers appear in December and the blooming period extends into March, the nuts ripening the next autumn. These nuts are borne in long, pendant racemes of 6 to 24 nuts each. Only the larger ones are fertile and the extremely hard shell renders the cracking of the nuts a difficult operation. They resemble filberts somewhat in appearance and taste but are said to excel all other nuts in flavor and to sell in the English market at \$2.50 per pound. In Australia the price averages \$1.25 per pound, when sold for propagation purposes. Australian writers inform us, further, that the trees are there planted 20 feet apart, attain a height of 50 feet, come into bearing when seven years old, and yield 3 to 14 nuts to each raceme. It would seem that some parts of California are fully as well adapted to the tree as any part of Australia, where the production of its nuts is considered to be very remunerative.

Maytenus Boaria Mol.

MAYTEN.

A glabrous evergreen tree of graceful habit, 15 to 40 ft. high or more, the crown broad and spreading, the slender branchlets pendant: leaves alternate, lanceolate, much narrowed to each end, finely and evenly serrate, 1 to 1½ in. long: flowers small, greenish, in small clusters along the leafy branchlets, the staminate with calyx-teeth petals and stamens 5 each: capsule splitting into 2 widely spreading valves: seeds with a scarlet aril. Synonym: *M. chilensis* DC. Family Celastraceae. Chile, northern Patagonia, etc. Illustrations: Pl. 9; *Bot. Reg.*, xx, pl. 1702; Bailey, fig. 1382.

The Chilean Mayten may now be seen at a number of places in California, and is becoming more and more a favorite. Its chief claims for consideration are its graceful habit and delicate smilax-like foliage. Because of the rounded top, pendant twigs, and modest color, it harmonizes well with other shrubs and trees, except those of a rigid, pyramidal habit. The twigs have been used for interior decoration with good results, and when woven into the meshes of a large net the effect is very suggestive of a bank of smilax.

This tree endures pruning well and when the lower branches are removed makes a fair shade tree, where the densest of shade is not desired. It is well adapted to lawn planting and is most beautiful when the branches are allowed to sweep the sward. Being a slow grower it is well adapted to places where tall trees are objectionable, and by occasionally removing the top-most growths, it may be kept as a shrub for 10 or 15 years. A lawn specimen in Berkeley has grown to a height of 15 feet in 7 years, while trees about 20 years old are 30 to 35 feet high. At Pasadena one of these plants grew 12 feet in 3 years.

Although seldom seen as a street tree, there is little doubt that the Mayten will prove itself useful for this purpose on rather wide streets where evergreens are desired. It will need attention, however, to prevent the central shaft from dividing into several branches. All but one of these should be removed as soon as formed.

The Mayten flourishes equally well in middle and in Southern California, along the coast and in the interior. It is propagated from cuttings taken in the fall, or from seed. Volunteer

seedlings are not uncommon under old trees and root-suckers also appear in some cases.

Roupala PohlII Meisn.

ROUPALA.

A tall narrow evergreen tree with smooth gray and somewhat mottled bark, the young shoots and leaves rusty with numerous woolly hairs, the mature foliage glabrous, glossy and dark green: leaves compound, 1 ft. or more long; leaflets 5 to 8 pairs, short-stalked, ovate, acuminate, oblique at base, 4 or 5 in. long, about 2 in. broad, coarsely toothed: flowers yellowish, in erect racemes which are 3 to 5 in. long: perianth with 4 narrow lobes: ovary and style single: fruit a hard 2-valved capsule. Synonym: *R. corcovadensis* Hort. Family Proteaceae. Brazil. Illustration: *Bot. Mag.*, pl. 6095.

Of the three or four specimens in California of this strikingly handsome plant, the finest is perhaps the tree on the Gillespie place at Montecito, near Santa Barbara. This is now 13 years old, but was once broken off by the wind; the present height of 30 feet represents the growth of about 7 years.

The foliage of this tree is unlike that of any other and constitutes its chief charm. The long, compound leaves curve gracefully outward, many of them becoming pendant, and thus the tree is clothed with a shining mantle of green. The young shoots, bronzed throughout with a soft, rusty tomentum, add color to the foliage during the spring months.

Roupala is a tree for only a few gardens, being somewhat sensitive to frost and easily broken by winds. A warm, sheltered place should therefore be chosen. It is, moreover, difficult to procure. Experiments with cuttings have so far failed and seeds can be had only by importation from Brazil. Further trials with cuttings should be made, since this method is apparently successful in England, the cuttings being "inserted in sand, under glass, with bottom heat" (Nicholson).

Choisya ternata HBK.

CHOISYA.

A compact free-blooming bush, 3 to 5 ft. high (said to reach 10 ft. when trained against warm walls), the young parts minutely hairy: leaves opposite, compound, the common petiole $\frac{1}{2}$ to 2 in. long; leaflets

3, narrowly obovate, obtuse, tapering to a sessile base, entire, $1\frac{1}{2}$ to $2\frac{1}{2}$ in. long, marked with minute oil-dots: flowers white, $\frac{3}{4}$ in. across, in forking terminal clusters: sepals and petals 5 each: stamens 10: pistil solitary. Family Rutaceae. Mexico. Illustrations: Pl. 10; HBK. *Nov. Gen. et Sp.*, pl. 513.

Choisya ternata is perhaps the most desirable small shrub now grown in California, one which has been thoroughly tested in a variety of situations, and yet it is scarcely known outside of a few parks and a limited number of private gardens. It is exceedingly neat and trim in appearance, round-topped, and the leaves are of that smooth, glossy texture which easily sheds dust and keeps clean even through a long, dry summer. The blossoms, comparable to those of the orange but scarcely fragrant, occur in abundance, five or six "crops" appearing each year, at least when grown in warm situations near the sea. The flowers appear in greatest abundance, however, during the early spring months. Although a native of Mexico, it grows only at considerable altitudes in that republic, and flourishes in California both along the coast and in the interior, from San Diego to San Francisco, and would undoubtedly do well much farther north. It has been known to endure a minimum temperature of 10° F.

Choisya is recommended for small lawns and yards, especially for city lots and for interior courts. In Golden Gate Park, San Francisco, it is used to good effect in masses, one planting of some 200 specimens being especially pleasing when in full bloom. This shrub is said to be grown in England as a hedge plant, such hedges being as broad as high, round-topped, and quite satisfactory whether in flower or only in foliage.

Propagation is by means of cuttings taken between the periods of bloom. Fertile seeds rarely form on cultivated plants, and their importation is impracticable. *Choisya* was first described from cultivated plants whose exact origin was unknown. It has since been discovered in the vicinity of San Luis Tultitlanapa, near Oaxaca, and elsewhere in Mexico.

Streptosolen Jamesonii Miers.**STREPTOSOLEN.**

An evergreen rough-pubescent shrub, usually 3 to 6 ft. high: leaves short-stalked, oval, narrowed to each end, entire, $\frac{3}{4}$ to $1\frac{1}{2}$ in. long: flowers showy, rich orange, in loose terminal clusters: calyx tubular, 5-toothed: corolla tubular-campanulate, 5-lobed, 1 in. long, $\frac{1}{2}$ to $\frac{3}{4}$ in. wide across the expanded limb, the tube twisted below: perfect stamens 4: capsule 4-lobed. Synonym: *Browallia Jamesonii* Hort. Family Solanaceae. U. S. of Columbia. Illustrations: *Bot. Mag.*, pl. 4605; Bailey, fig. 2436.

Commonly grown as a flowering shrub, *Streptosolen* is equally satisfactory when trained against walls or on a trellis, since in habit it is half-climbing. Left to itself it spreads out into irregular but graceful masses 15 or 20 feet across and 4 to 6 feet high; if taken in hand when young and carefully pruned it may be made to assume an upright form with a more or less distinct trunk, and has been trained on walls to heights of 10 feet or more. Whatever the habit, it blooms profusely at all seasons and is especially adapted to situations calling for masses of color during the winter months. Partial shade does not seem to discourage this shrub, for in San Mateo County I have seen it blooming profusely beneath oak trees in April. A light soil is necessary for its best development. It is therefore recommended for almost any situation where the color harmonizes with its surroundings and where the temperature does not fall much below the freezing point. It might well replace much of the *Lantana* so commonly grown in California.

It must be remembered, however, that *Streptosolen* is a tender plant. It sometimes freezes in the San Francisco Bay district, but only when grown on low ground. In the coastal region from San Luis Obispo south it is perfectly safe except in the coldest situations. It is used as far inland as Redlands, but at that place it is necessary to select warm situations.

Cuttings grow readily and afford a very satisfactory method of propagation. In England cuttings are struck in the spring and grown in 10-inch pots without pinching, the result being tall plants for the greenhouse, clothed with fine trusses of bloom during the winter months. (See further in *Gardeners' Chronicle*, ser. 3, xxxi, 84 and xxxvii, 375.)

***Solanum Rantonnetii* Carr.**

BLUE-FLOWERED SOLANUM.

An erect bushy plant, 4 to 10 ft. high, or may be trained as a vine to 15 ft.: leaves soft with microscopic hairs, alternate, lanceolate, narrowed to each end, entire, very variable in size: flowers slender stalked, violet-blue, nearly 1 in. across: calyx 5-toothed: corolla rotate, 5-angled: stamens 5, attached to the corolla, the anthers oblong and connivent: fruit a 2-celled berry, red, drooping, very ornamental, many seeded. Family Solanaceae. Paraguay and Argentine. Illustration: Pl. 11, fig. 1.

This plant, which may be considered either as a shrub or as a vine, depending upon the method of pruning, is being successfully grown in a number of southern California gardens. It is recommended for situations where a mass of blue color is desired at all seasons of the year, since it is a continuous as well as a profuse bloomer, the flowers forming in clusters over nearly all the exposed area.

The growth is rapid and a single vine has been known to make an almost solid wall 15 feet long by 12 feet high. Its effectiveness is increased by planting with it some yellow-flowered vine.

When treated as a shrub, *Solanum Rantonnetii* produces a solid mass of foliage and many flowers. For this purpose the lower branches should be pruned back and the whole plant headed in occasionally. Only moderate irrigation is to be practiced if an abundance of bloom is desired, since ordinary watering, such as is given to most shrubs, has a tendency to check its flowering proclivities. It is eminently adapted to dry situations.

Propagation is easily accomplished by means of cuttings. It also comes readily from seed.

Other species of *Solanum* are better known in cultivation. *S. jasminoides*, often called "potato vine," is the most popular. It is noted for its large clusters of white flowers, but sometimes has a tendency to cast its leaves and thus become ragged or twiggy.

***Buddleia madagascariensis* Lam.**

MADAGASCAR BUDDLEIA.

A loose straggling shrub (but easily controlled by pruning), becoming 15 to 20 ft. high, the stems petioles pedicels and under surface of the

leaves clothed with a dense rusty tomentum: leaves green above, opposite, ovate-lanceolate, acuminate, tapering or rounded to short stalks, entire or nearly so, often 6 in. long: flowers fragrant, of a yellowish orange color, borne in long slender trusses which are frequently pendant: calyx shortly 4-toothed: corolla funnel-shaped, the tube about $\frac{1}{4}$ in. long, cottony, the 4 lobes short and roundish: stamens 4, inserted at the mouth of the corolla-tube: style single, as long as the stamens: berries of a beautiful translucent blue color. Family Loganiaceae. Madagascar. Illustrations: *Bot. Reg.*, xv, pl. 1259; *Bot. Mag.*, pl. 2824.

This *Buddleia* is cultivated only to a limited extent in California, where it was first introduced by Dr. Franceschi, of Santa Barbara. It may be either trained into an erect, bushy form, or allowed to clamber over other plants, rockeries, or unsightly objects. As a matter of fact, this latter is perhaps its most important use, since it is too coarse for ordinary "front-yard" planting and the old flowers, drying to a disagreeable brown, persist long after they have ceased to be ornamental. For certain positions, however, such as filling up odd corners, covering an unsightly water-tank or shed, etc., nothing is more satisfactory.

It is most effective when trained up so that the branches clear the ground; the rounded tops when properly supported may then attain a height of 20 feet and give a spread fully as great.

The growth is rapid and the long, drooping branches, densely clothed with the ashy-gray leaves, present a pleasing sight, to which is added, during the spring and summer months, the brilliancy of the yellow flowers borne profusely in long panicles. These are followed in autumn by the blue berries. The plant is perfectly hardy throughout western California.

Three other species of *Buddleia* are cultivated in California. The more common of these is *B. globosa*, a low bush with yellow flowers in globular heads. It is a serviceable bedding plant, much used throughout the state and easily grown, but with no special features to commend it. (See *Bot. Mag.*, pl. 174.)

B. Lindleyana is less generally known but has the most beautiful flowers of all. They are of a royal purple color and velvety on the inner surface, in long racemes or panicles, the lower ones dropping off as new buds open. Leaves green on both sides. Half deciduous but hardy and should be freely used. (See *Bot. Reg.*, xxxii, pl. 4.)

B. variabilis may be known by its coarsely serrate leaves, white-cottony beneath, and by the glabrous corolla, which is lilac with an orange-yellow mouth. Rare in California but grown at Goleta and Hollywood. Hardy and a very desirable sort. The var. *Veitchiana* is said to be superior even to the typical form. (See *Bot. Mag.*, pl. 7609.)

The propagation of *Buddleias* is best carried out by the use of cuttings. This is particularly important if it is desired to exactly reproduce any special form. Such a case is a strain of *B. madagascariensis* which has yellow tomentum and more flowers than the ordinary sort, but does not come true to seed. When trimmed back they branch freely and put out numerous shoots. *B. globosa* is almost weed-like in this respect and sprouts up even if cut back to the root.

***Acokanthera spectabilis* Benth.**

WINTERSWEET.

A trim erect shrub of columnar habit, 4 to 6 ft. high, glabrous almost throughout: leaves leathery, shining above, opposite or alternate, elliptic or broadly lanceolate, very acute, short-stalked, entire, 3 or 4 in. long: flowers jasmine-scented, white tinged with rose or suffused with pink, in dense terminal and axillary clusters, withering-persistent: calyx short, 5-cleft: corolla minutely pubescent without, slenderly tubular, about 1 in. long, the limb parted into 5 lanceolate or ovate lobes: stamens and style included: fruit berry-like, nearly black, the size of a plum. Synonym: *Toxicophlaea spectabilis*. Family Apocynaceae. South Africa. Illustration: *Bot. Mag.*, pl. 6359.

In this shrub we find a true aristocrat. It carries itself with pride and dignity, and like many another exotic which, in the eastern states, demands the solicitude of hot-house culture, is easily grown in southern California as a yard-plant.

Because of its moderate size and slender habit, the Wintersweet is eminently adapted to small yards and lawns. It can be used to good effect in formal planting, either singly or in rows. For this purpose it is much more effective than the European Bay so often used.

Commonly clothed with a rather dense foliage, it is found that in some situations this shrub has a tendency to cast many of its leaves. In this case the twiggy appearance may be rem-

edied by pruning back, thus inducing a growth of new foliage. The flowers are neat and pretty but are withering-persistent. If one is not content to wait a few weeks for them to fall they may easily be plucked by hand (since they grow in clusters) or knocked off with a rake. The fruit is presumably poisonous but it is also exceedingly bitter, so that there is no danger of its being eaten by children or domestic animals. The bark is well known to yield a virulent poison.

The minimum temperature which this plant will endure has not been definitely determined, but it is probably not far below the freezing point. It passes safely through the winters at Santa Barbara and Los Angeles and should be tried on a small scale farther inland and in middle California. It is indifferent to neglect and lack of irrigation.

Propagation is readily effected by seeds. Cuttings are rooted without difficulty.

Feijoa Sellowiana Berg.

FEIJOA.

An erect shrub or small tree, with brown bark: leaves opposite, thick, 2 or 3 in. long and half as broad, oblong, obtuse, short-stemmed, deep green and shining above, white-tomentose beneath: flowers solitary, axillary, $1\frac{1}{2}$ or 2 in. broad, the flower-stalk 1 in. long: calyx-lobes orbicular, reflexed: petals 5, orbicular, spreading, internally blood-red with white margins: stamens numerous, red, the anthers yellow: ovary inferior, 4-celled: fruit oblong, 2 in. long, many-seeded, yellowish green, fleshy, very aromatic. Family Myrtaceae. Southern Brazil, Uruguay, etc. Illustrations: Pl. 11, fig. 2; *Bot. Mag.*, pl. 7620; *Gard. Chron.*, ser. 3, xxiv, fig. 134.

In speaking of ornamental shrubs for California, mention should perhaps be made of this South American fruit, since it is highly ornamental as well as useful. This is not the place to speak of its economic features, but those who are interested in the introduction of new, high-class, money-making fruits, will do well to give attention to the Feijoa, which is certain to become very popular.

The beauty of this shrub lies in its foliage and flowers. The green upper surface of the leaves contrasts finely with the white lower surface, and the parti-colored flowers are strikingly handsome and unusual both in color and form.

Feijoa is much more hardy than the orange, and so may be grown in most of the settled portions of our state. It is not particular as to soil and apparently endures a moderate amount of drought. (See further account in *Pacific Garden* for June, 1908, and for July, 1909.)

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PLATE 1.

Pittosporum phillyraeoides DC. NARROW-LEAVED PITTOSPORUM.

A tree grown at Santa Barbara, California, in a neglected corner. The pendant habit is characteristic and the leaves persistent. Flowers yellowish, inconspicuous.

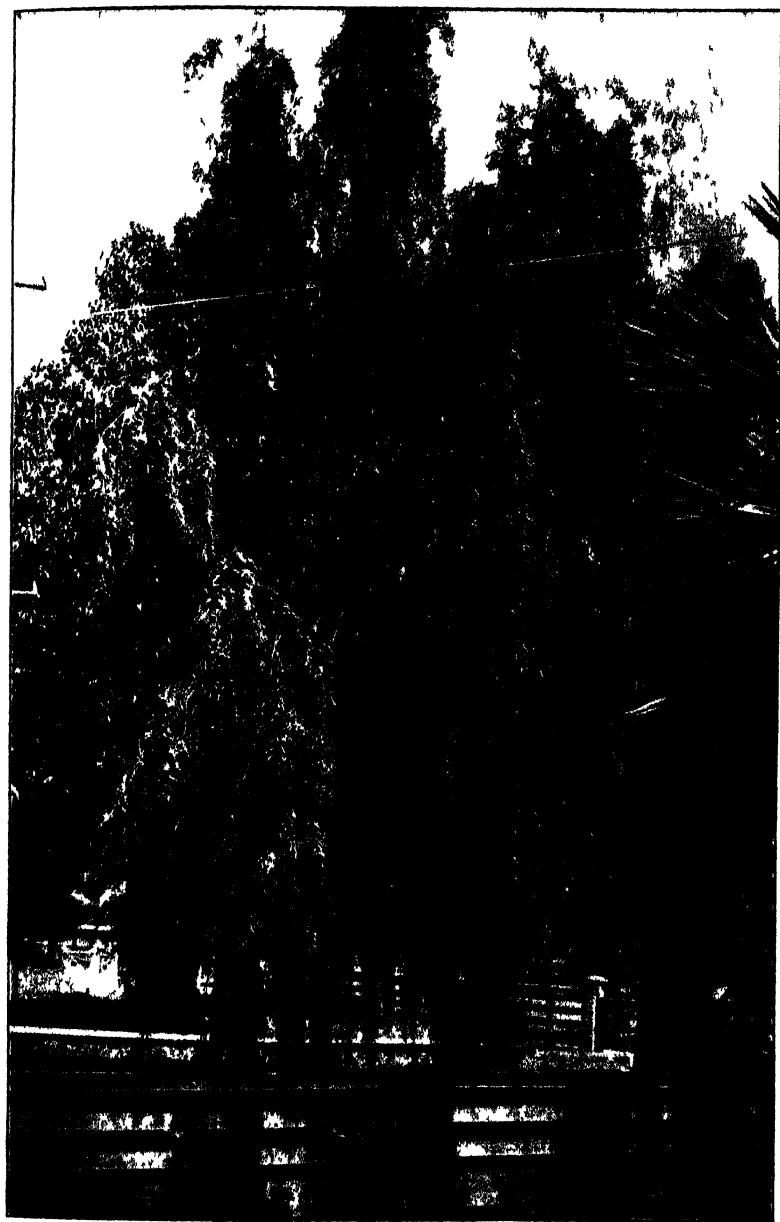


PLATE 2.

***Callistemon speciosus* DC.**

A tree growing in Santa Barbara, California. About twenty years old, forty feet high. Usually only a bush in California. Flower-clusters bright red, large, pendant.



PLATE 3.

1. **Melaleuca hypericifolia** Sm.

- a. Flower-cluster. (One-half natural size.)
- b. Cluster of old capsules. (Reduced.)
- c. Fascicle of stamens. (Somewhat enlarged.)

2. **Melaleuca lateritia** Otto.

- a. Flowering branch. (One-half natural size.)
- b. Spike of old capsules, showing the spiral arrangement. (One-half natural size.)
- c. Four old capsules. (About natural size.)
- d. Flower. (Enlarged to one and one-third natural size.)

3. **Melaleuca linariifolia** Sm.

- a. Flowering branch. (About natural size.)
- b. Branch terminated by five spikes of unopened buds, old capsules below. (About one-half natural size.)
- c. Flower. (Enlarged.)
- d. Old capsules. (About natural size.)

4. **Melaleuca fulgens** R. Br.

- a. Branch, showing flower-cluster and a spike of unopened buds.
- b. Flower dissected vertically.
- c. Pistil.

All drawn from nature by Mrs. Louise Nash, except figure 4, which is from Lindley's *Botanical Register*, plate 103.

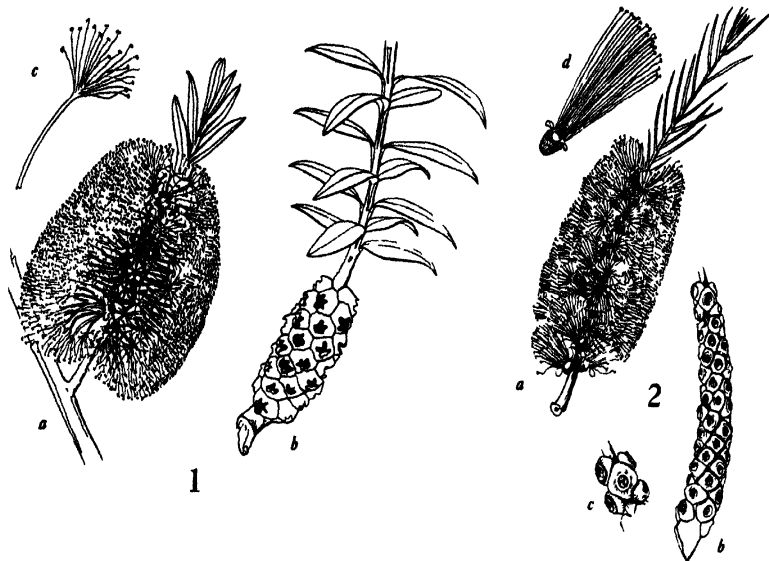


PLATE 4.

1. *Melaleuca decussata* R. Br.

- a. Flowering branch. (Natural size.)
- b. Branch with unopened buds showing the decussate arrangement.
- c. Flower. (Enlarged.)
- d. Petal and a fascicle of nine stamens. (Enlarged.)
- e. Twig with old capsules and scars of fallen capsules. (Somewhat reduced.)

2. *Melaleuca armillaris* Sm.

- a. Flowering branch. (Reduced to one-half natural size.)
- b. Cluster of old capsules. (Nearly natural size.)
- c. Leafy branch and cluster of buds with their subtending bracts. (About natural size.)
- d. Flower. (Enlarged.)
- e. Petal and fascicle of nine stamens. (Enlarged.)

3. *Melaleuca leucadendron* L. CAJUPUT TREE.

- a. Flowering branch, with capsules of the previous year below. (One-half natural size.)
- b. Three capsules. (Enlarged.)
- c. Leaf, showing the venation. (One-half natural size.)
- d. Flower. (Enlarged.)

4. *Melaleuca styphelioides* Sm.

- a. Flowering branch. (Natural size.)
- b. Branch with unopened buds and a few bracts. (Natural size.)
- c. Portion of stem showing the pubescence, and leaf with veins. (Nearly twice natural size.)
- d. Flower. (Enlarged.)

All of the figures drawn by Mrs. Louise Nash.



PLATE 5.

1. **Melaleuca parviflora** Lindl.

- a. Flowering branch. (A little more than natural size.)
- b. Section of the stem with basal portion of three leaves. (Enlarged.)
- c. Single flower. (Enlarged.)
- d. Stem with young capsules and a few persistent leaves. (Enlarged.)
- e. Old capsules on a stem from which all of the leaves have fallen. (Enlarged.)

2. **Melaleuca nodosa** Sm.

- a. Flowering branch with capsules of the previous year at the base. (Natural size.)
- b. Single flower. (Enlarged.)
- c. Cluster of six stamens. (Enlarged.)
- d. Leaf, showing the oil-dots. (Enlarged.)

3. **Melaleuca ericifolia** Sm.

- a. Branch, showing capsules of the year on the upper portion, and a cluster of older capsules below. (Natural size.)
- b. Capsule seen from above. (Enlarged.)

4. **Melaleuca nesophila** F. Muell.

- a. Flowering branch with a cluster of capsules of the previous year at the base. (Reduced to three-fourths natural size.)
- b. Fascicle of nine stamens. (Enlarged.)

5. **Melaleuca Huegelii** Endl.

- a. Flowering branch with some unopened buds above, and a spike of buds to the right. (About one-half natural size.)
- b. Flower. (Enlarged.)
- c. Portion of stem showing the appressed leaves. (Enlarged.)
- d. Old capsules massed about the stem. (Reduced.)
- e. Three capsules. (Enlarged.)

All of the figures drawn by Mrs. Louise Nash.



PLATE 6.

Melaleuca armillaris Sm.

A vigorous specimen seven feet high, only two years old, bearing many pendant clusters of white flowers. Grown in Santa Barbara, California.



PLATE 7.

***Lyonothamnus floribundus* var. *asplenifolius* Brandegee. ISLAND IRON-
WOOD.**

Forty-five feet high, trunk diameter ten inches, age fifteen years.
Grown in the Botanic Gardens, Berkeley, California, from seed brought
from Santa Cruz Island by Dr. Franceschi.

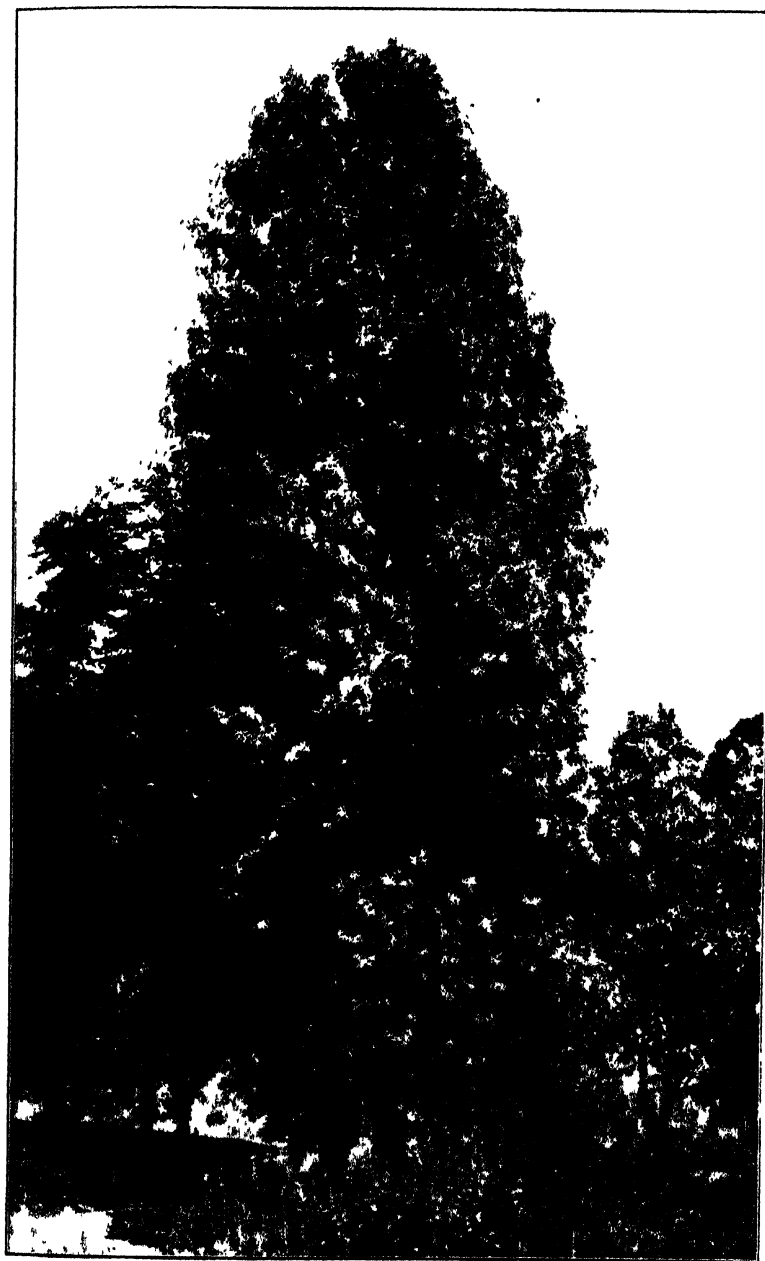


PLATE 8.

***Eugenia myrtifolia* Sims. AUSTRALIAN BRUSH CHERRY.**

Thirty feet high, trunk diameter eight inches, age fourteen years. Grown in Berkeley, California, in clay soil. Foliage evergreen, smooth and shining, with a pink tinge when young, becoming green as it matures. Flowers white, not conspicuous, followed by pinkish-green berries.

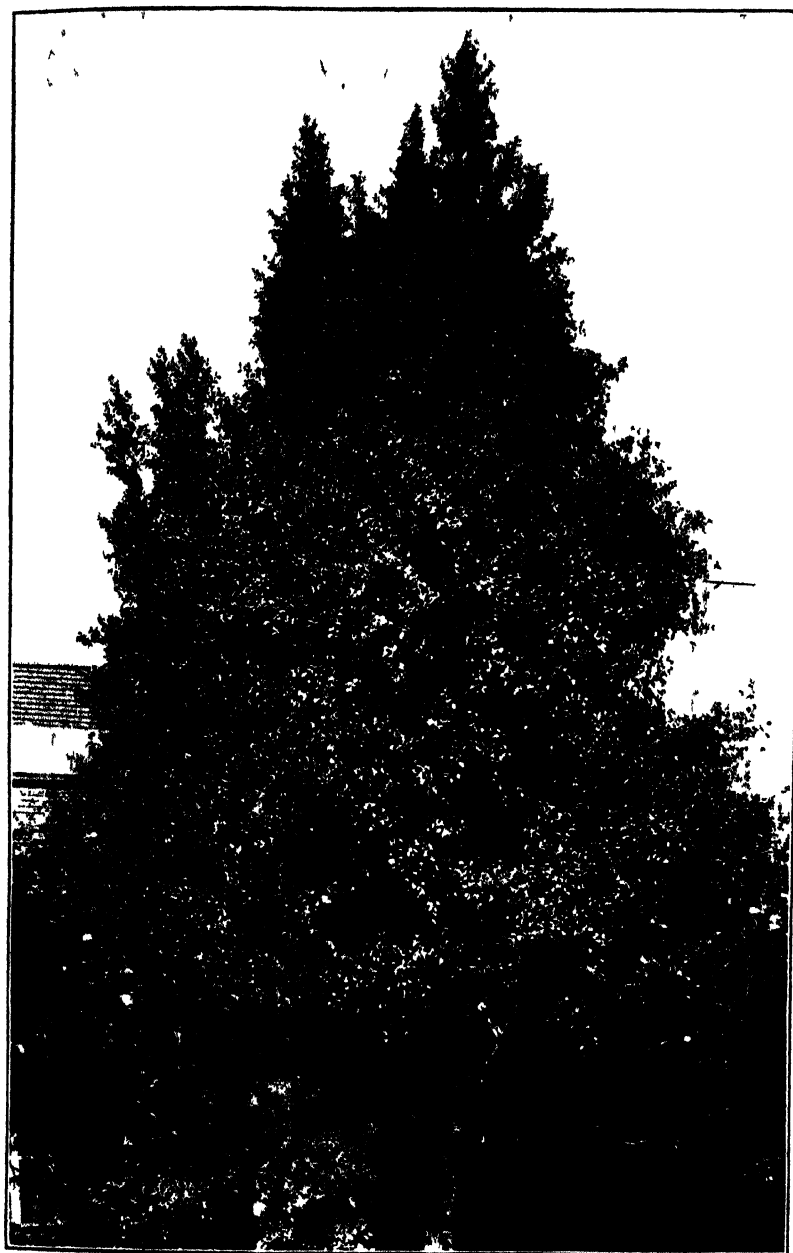


PLATE 9.

Maytenus Boaria Mol. MAYTEN.

A young tree of somewhat irregular growth. The pendant branches characteristic. Flowers inconspicuous. Grown in the Botanic Gardens, Berkeley, California. Valuable as a lawn tree and for avenue planting where an evergreen is desired.



PLATE 10.

Choisya ternata HBK. CHOISYA.

A typical plant, grown on the grounds of Hotel del Monte, California. Height five feet. Flowers white, occurring throughout most of the year, the photograph taken in April. Leaves ternately compound, green, smooth, and glossy.

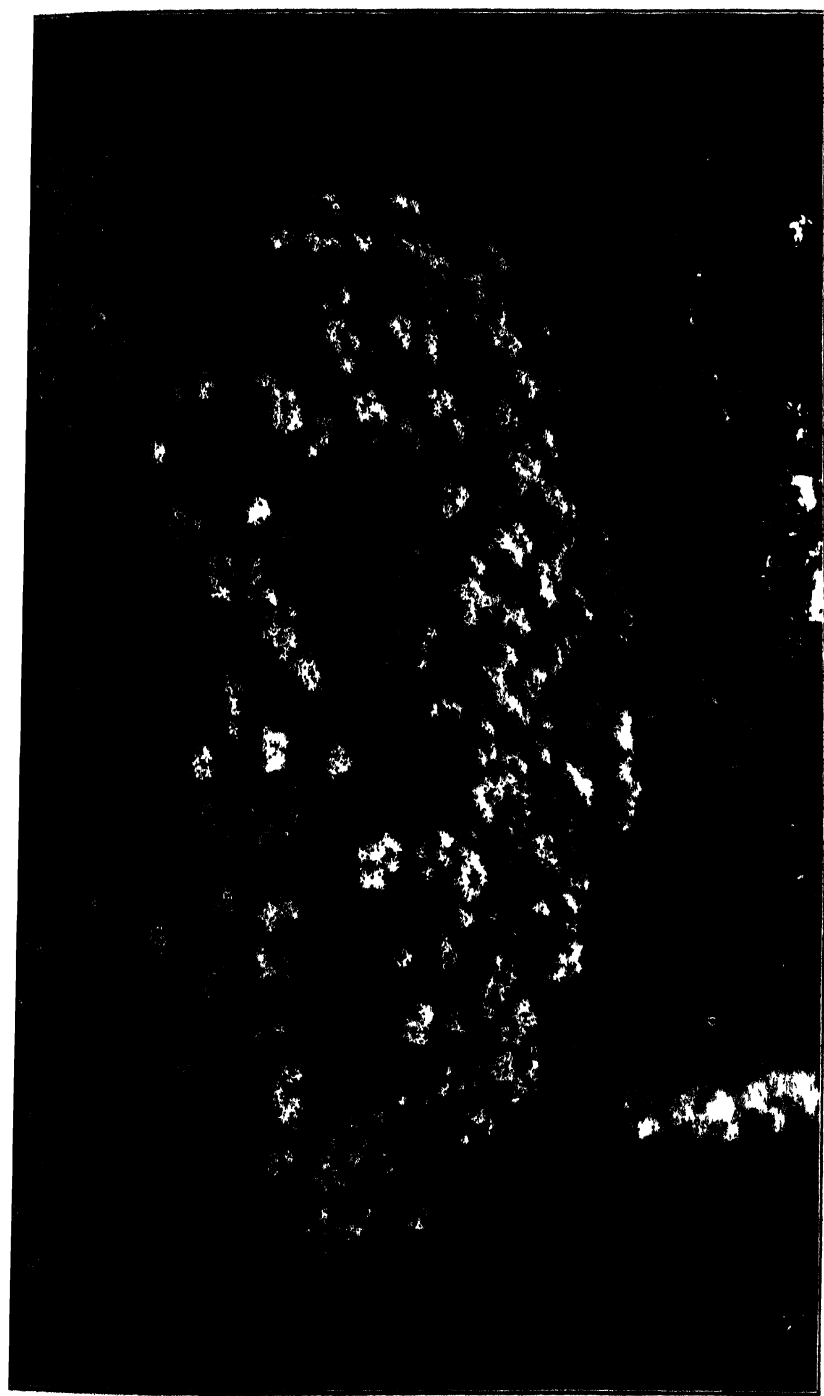


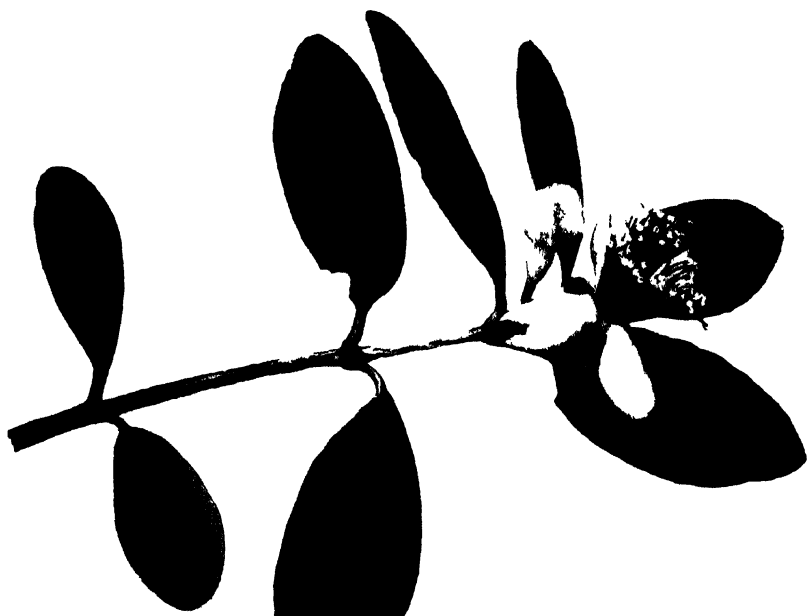
PLATE 11.

1. *Solanum Rantonnetii* Carr. BLUE-FLOWERED SOLANUM.

Branch taken from a vine twelve feet high, grown at Santa Barbara, California. Often trained as a flowering shrub and usually more floriferous than shown in this illustration. Flowers violet-blue.

2. *Feijoa Sellowiana* Berg. FEIJOA.

Flowering branch from a plant grown at Pasadena, California. Petals red, the inrolled margins white. Leaves green above, white-silky beneath. The plant is a tall shrub, grown as an ornamental and also for its perfumed fruits.



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GRACILARIOPHILA, A NEW PARASITE ON
GRACILARIA CONFEROIDES.*

BY

HARRIET L. WILSON.

On *Gracilaria confervoides*, in San Francisco Bay, there occur profusely scattered tubercles or granules that resemble adhering sand grains, or small particles of rice. To determine what these tubercles are, whether pathological excrescences belonging to, or parasitic growths on, the *Gracilaria*, a systematic study of them was begun in the autumn of 1907. At several different times during the autumn of that year specimens were obtained from a low rocky beach in the vicinity of Fort Point. This beach, when exposed by the ebb tide, is shown to be a favorite locality for a great variety of algae.

Since these tubercular growths were first observed here, there has been seen what appears to be the same thing on *Gracilaria confervoides* at Monterey, and on *Gracilaria multipartita* at San Pedro. This would suggest, at least, that they are generally present on the *Gracilarias* of the coast of California.

Of the material collected, some was used for immediate study, and some was preserved in a two per cent. solution of formalin, for later use. The first sections studied were made with a razor; but they were necessarily too thick, or too mangled to be satisfactory except in a general way. The next sections were from specimens that had been dehydrated, imbedded in paraffine, and sectioned on the microtome. Some of these sections were stained

* A thesis presented in partial fulfillment of the requirement for the degree of Master of Science in the College of Natural Sciences, of the University of California, May, 1909.

in an aqueous solution of Bismarck brown, and some in a fifty per cent. glycerine solution of Hoffman's purple; and then mounted in balsam. Staining was resorted to for the purpose of differentiating the tissues of the tubercle, if possible, and to make one part of the section more clearly distinguishable from another part. The experiment was not satisfactory, however, as the sections stained uniformly throughout.

Other microtome sections were made by a freezing process. These were not stained; but were mounted in balsam direct, and were the most satisfactory sections, because of their uniform thickness and their straight horizontal or vertical surfaces. Specimens boiled in a saturated aqueous solution of corrosive sublimate and crushed afforded but little, if any, additional information.

The granules, or tubercles, range in size from a mere speck to the half of an ordinary rice-grain; or, more exactly, they are from one to two millimeters in any diameter. They are normally spherical in shape. When they are not spherical it is because they are pressed out of shape from being crowded close together. A single, separate, normal specimen, not misshapen by being crowded, is not lobed on the surface; but is smooth and uniformly spherical. The color is white; usually so white that against the dark *Gracilaria* it makes the tubercle very conspicuous. When the color appears to be yellowish, or brownish, it is, no doubt, due to extraneous substances; but there is not shown the least suggestion of green or red, as might naturally be expected from the close relationship existing between the tubercle and the *Gracilaria*.

Superficially the tubercles are alike; but in reality they are of three different kinds, each kind devoted to the development of its particular organ of reproduction, the tetrasporangia, antheridia, and cystocarps. These different kinds of tubercles are absolutely indistinguishable from one another, except in section under the microscope. There is no significance in the place they occupy on the *Gracilaria*; nor does their size offer any aid in determining their identity; for the smallest, as well as the medium, and the largest show well-developed organs of reproduction.

Structurally, too, the tubercles are much alike. They are composed of the same tissues, that bear the following relation to one another: the larger portion, the central or innermost mass, consists of large, thick-walled cells that conform to no apparent arrangement, but are pressed close together and filled with a granular substance. Around this central area is a layer of cortical tissue, in which, in the tetrasporic and antheridial tubercles, the organs of reproduction are born. Surrounding this cortical area, and enveloping the entire tubercle, is a relatively thick, structureless membrane. Thus in structure as well as in superficial form and appearance there is almost no resemblance between the tubercle and the *Gracilaria* on which it is found. *Gracilaria confervoides*, outwardly, has the appearance of long, very delicate, cylindrical, or filiform, fronds that branch profusely. Structurally, the interior area is composed of very large, thick-walled, angular cells that gradually become smaller toward the cortical layer by which they are surrounded. These cells contain no granular substance, but are clear and transparent. The cells of the cortical layer are small, angular, and contain granular protoplasm.

Beneath the tubercles, penetrating the cortical layer, and extending into the intercellular tissue of the *Gracilaria*, are filamentous or rhizoidal processes. The cells of these filamentous processes are filled with a granular substance and resemble the cells of the large central mass. These filamentous processes, pushing downward and filling the intercellular spaces of the *Gracilaria*, presumably serve as a source of food-supply, nourishing the external tubercle at the expense of the tissues penetrated. By pushing downward and crowding between the cells of *Gracilaria*, these rhizoidal filaments often isolate the cells and give to them the appearance of having been carried up into the tissues of the tubercle.

The tetrasporic tubercle consists of a large central area of granular cells, surrounded by a layer of cortical tissue. The cells of the central area are large compared to the cortical cells, but they are small compared to the central cells of the *Gracilaria*. They are angular, thick-walled, and filled with granules. The cortical tissue consists of uniform chains of

small clear cells, radiating in all directions from the central area of granular cells, perpendicular to the surface of the tubercle. Uniformly distributed over the surface of the tubercle, among these chains of cells, the cruciately arranged tetrasporangia are born. Each tetrasporangium is surrounded by five to eight filamentous chains of long sterile cells that have a common origin at its base. These sterile filaments, beside having an incurving tendency, branch toward the top, or outer end, and thus serve to hold the sporangium until it attains maturity, when the tetraspores are allowed to escape. The tetrasporangium is an elliptical spheroid in shape, its long and short diameters crossing each other at right angles. These diameters measure 16μ by 35μ , so that the length of the tetrasporangium is a little more than twice the width. (Plate 13, fig. 4.)

The antheridial tubercle also consists of a large central mass of granular cells, surrounded by a layer of cortical tissue. The cells of this central area are the same in size as those of the same area of the tetrasporic tubercle. They are angular, thick-walled, and filled with granules. The cortical tissue consists of uniform chains of fertile and sterile cells, which radiate in all directions from the granular cells of the central area, perpendicular to the surface of the tubercle. From the terminal, or outer, end of the fertile filaments of this cortical layer the antheridia are produced. The fertile filament is composed of from three to five cells, the basal cell being obovate in shape, tapering gradually from the apex to the base. From the apex of this basal cell the antheridial chain arises. From the outer end of this antheridial chain, of two or three cells, the antheridia are cut off, one after the other, and escape through the dissolved structureless membrane that surrounds the entire tubercle. The antheridia are 5μ in diameter, and perfectly spherical. Each antheridial chain is accompanied by a sterile filament whose basal cell is of the same shape and has the same origin as the basal cell of the antheridial chain. The sterile filament is composed of fewer but longer and narrower cells than the antheridial filament. (Plate 13, fig. 3.)

The cystocarpic tubercle is almost entirely involved in the

production of the cystocarp. In the cystocarp, the area of large, angular, granular cells is very much reduced, occupying the lowest possible position and forming the slightly raised cushion-like placenta in the bottom of the cystocarp. From the under side of the placenta the rhizoidal filamentous processes project into the intercellular tissue of the *Gracilaria*. From the upper rounded surface of the placenta arise the oöblastema filaments which produce the carpospores.

The oöblastema tissue is arranged in moniliform filaments, the basal cells of which are also obovate in shape, tapering gradually from the apex to the base. From the apex of this basal cell arises a chain of uniformly spherical cells, the carpospores. The carpospores are 16μ in diameter. They are successively cut off from the end of the carpogonial chain into the lunate fruiting cavity that occupies the space between the placenta and the overarching pericarp. Accompanying each oöblastema filament are one or more sterile filaments whose basal cells are of the same shape, and have a common origin with the basal cell of the oöblastema filament. The sterile filament is composed of fewer but longer and narrower cells.

Above the lunate fruiting cavity is an overarching wall, or pericarp, of relatively great thickness. It is composed of chains of from eight to ten thick-walled rectangular cells. These chains of cells are perpendicular to the external surface of the cystocarpic tubercle. Outside of this area of rectangular cells is a single layer of long, narrow, thick-walled palisade cells. Beyond the palisade cells is the structureless membrane that surrounds the entire tubercle. Through the thick, protecting wall of the cystocarp there is an opening, shaped and placed like an inverted funnel, the carpostome. The carpostome affords the means of communication of the fruiting cavity with the outside, and furnishes a way by which the mature carpospores escape from the cystocarp. More than once we have found cystocarps having two carpostomes; but whether it were really two openings to one placenta, or a case of fused placentas, we were unable to determine satisfactorily. When a cystocarp has but one carpostome, it is placed perpendicularly over the center of the placenta. When there have appeared to be two they were so

placed that lines drawn through them, if extended, would meet in a right angle on the center of the placenta.

From the foregoing facts, arrived at by careful study and comparison, we can but deduce the following conclusions. The tubercle differs in tissue and structure from the *Gracilaria* on which it is found. It is provided with its own independent means of reproduction. It is furnished with numerous filamentous processes, or rhizoids, that serve as a means of nourishment; and being thus amply endowed for the exigencies of its own existence, it must be classed as an independent plant. This plant, showing entire absence of color, and provided with ample means of drawing its nourishment from another plant, must be classed with the parasites. Therefore, the tubercle in question is not an excrescence or other outgrowth of the *Gracilaria*, but a true parasite living on *Gracilaria confervoides* as host. It is to be compared, in this respect, with other parasites of the Florideae which form tubercles on hosts closely related to themselves, such as *Janczewskia* on *Laurencia*, and *Gonimophyllum* on *Nitophyllum*.

That this parasite is closely related to its host is shown by the similarity in structure and arrangement of their respective cystocarps. Since any cystocarps that could be recognized as such showed the presence of mature carpospores, we were unable to find any in a sufficiently young stage to show the presence of a trichogyne. Being unable to find the trichogyne, we could not study the *development* of the cystocarp but were compelled to rely solely, in comparison, upon the structure and arrangement of the adult cystocarps. The cystocarps of both the parasite and *Gracilaria* have basal placentas, from the surface of which radiate moniliform oöblastema filaments. They both have distinct carpostomes, and this resemblance must place them in the same suborder, Sphaerococcoideae. Notwithstanding these resemblances, there are also the following marked differences: The placenta of the parasite is low. It is rounded and cushion-like, but slightly elevated, even in the highest part. The placenta in the cystocarp of *Gracilaria* is not only rounded, but it is so raised that it "projects far into the cavity of the cystocarp." The parasite devotes the entire surface of the tubercle

to the production of its antheridia, while the antheridia of *Gracilaria confervoides* are borne in small sunken conceptacles which are scattered over the frond. These differences and the parasitic habit of the tubercle show that while it is closely related to, it is not the same genus, as *Gracilaria* and must consequently be referred to a new genus. In conjunction with Dr. Setchell, I, therefore, propose a new genus and species, *Gracilariophila oryzoides*, of which I append a description.

Gracilariophila Setchell and Wilson, gen. nov.

Parasitica, tuberculiformis in thallis Floridearum per filamenta rhizoidea penetrans; cellulis internis magnis diaphanis, cellulis externis parvis, granulatis, in seriebus antichinis dispositis; cystocarpio immerso, non prominente, placenta moderate rotunda, sporis catenatis, e placenta radiatis, pericarpio crasso per latum carpostomium centrale aperto; antheridiis superficialibus, effusis, seriatis; sporangiis in stratis superficialibus immersis, cruciatis.

Genus *Gracilaria* valde affine sed parasitica et thallo ad tuberculum reducto.

Thallus, forming tubercular growths on other red algae and penetrating the host by means of numerous rhizoidal filaments, cystocarp internal, like that of *Gracilaria*; antheridia and cruciate tetrasporangia scattered over the entire surface of the antheridial and tetrasporic fronds.

Gracilariophila oryzoides Setchell and Wilson, sp. nov.

Tuberculis sphericis aut lente irregularibus, albis, ad 2 mm. diametro, in *Gracilaria confervoides* et *G. multipartita* parasiticis.

In oris Californiae, prope San Francisco et Monterey, et, ut videtur, prope San Pedro. (Exemp. orig. in Herb. Univ. Calif. cons.)

Tubercles normally spherical; perfectly white in color; ranging from a mere speck to two millimeters in size; parasitic on *Gracilaria confervoides*.

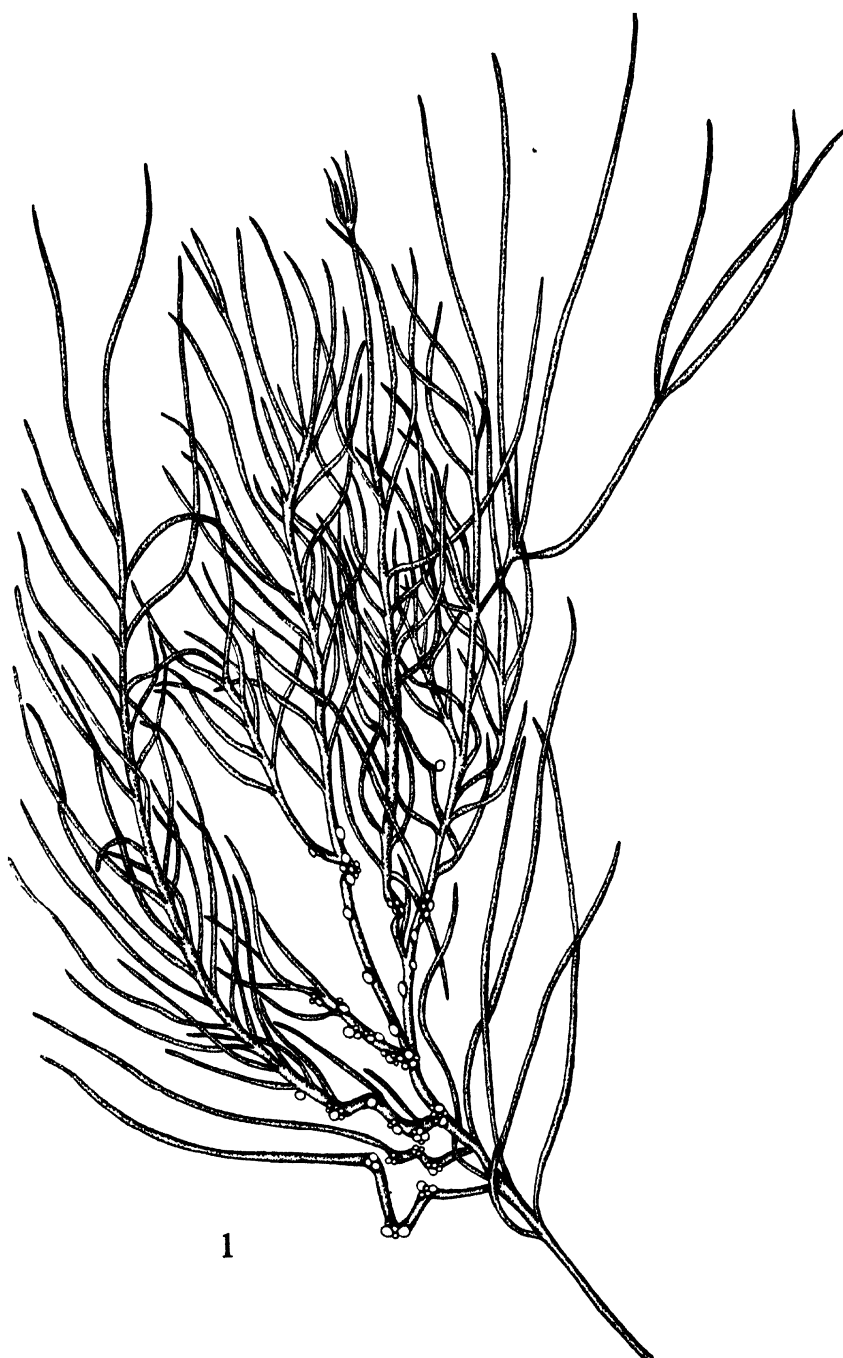
Localities: Fort Point, Monterey, and probably San Pedro, California, on *Gracilaria multipartita*. Type in the Herbarium of the University of California.

PLATE 12.

Gracilariophila oryzoides.

The figures are necessarily somewhat diagrammatic. Those of sections were drawn with the aid of the camera lucida.

Fig. 1.—A habit sketch of *Gracilaria*, showing the manner in which the tubercular *Gracilariophila oryzoides* inhabits it.



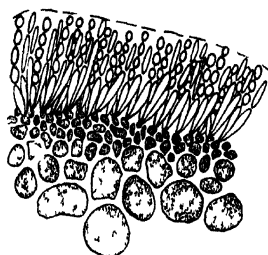
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PLATE 13.

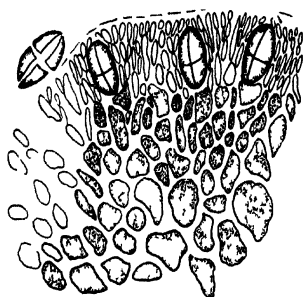
Fig. 2.—A vertical, median section through a mature cystocarpic plant and a cross section of the *Gracilaria* on which it is found. The lower part of the figure is the *Gracilaria*, the upper part the cystocarpic *Gracilariophila* with its low rounded placenta and the numerous rhizoidal filaments that penetrate the intercellular space of the *Gracilaria*.

Fig. 3.—A portion of an antheridial frond showing the granular cells of which it is constituted and the superficial layer of cortical tissue, bearing the antheridia.

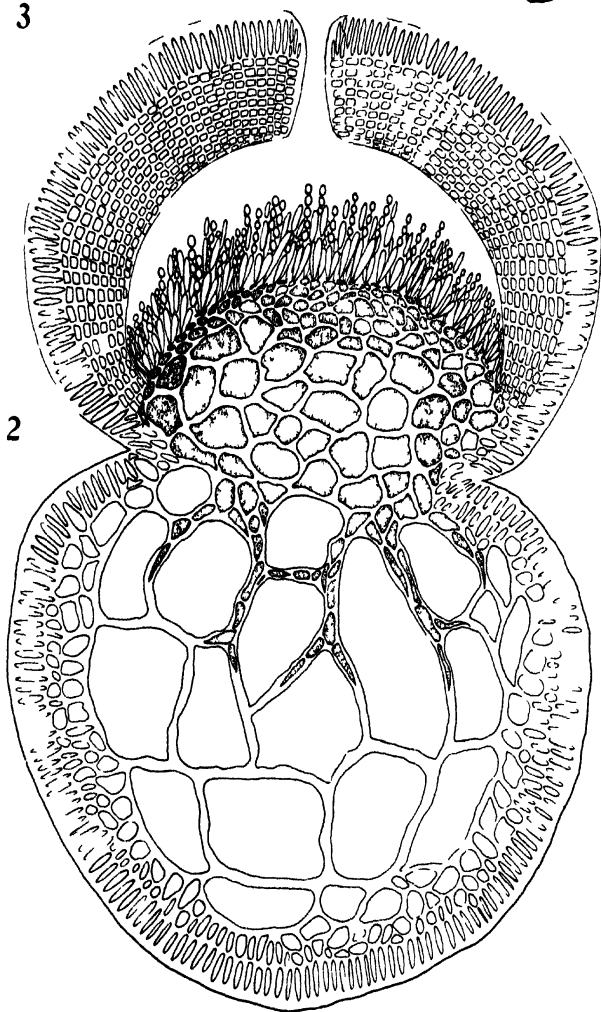
Fig. 4.—A portion of a tetrasporic frond showing the granular cells of the plant, and the cruciate tetrasporangia produced in the cortical layer.



3



4



2

PLANTAE MEXICANAE PURPUSIANAE, II.

BY

T. S. BRANDEGEE.

Nearly all of the plants described in the following pages were collected by Dr. C. A. Purpus in the state of Puebla, near the boundary line of Oaxaca. The few exceptions have the name of the collector and the locality noted with the description. The number under which the species has been distributed follows the description and the types are in the Herbarium of the University of California.

***Pithecolobium Purpusii* sp. nov.**

Ramis tortuosis vel flexuosis fuscis juventute pubescentibus: petiolis ca. 2 mm. longis pubescentibus; pinnis unijugis ca. 12 mm. longis glanduliferis; foliolis 7-8-jugis orbiculatis vel oblongis 5 mm. longis, 4 mm. latis, glabris supra nitidis, basi 3-4 venis; stipulis spinescentibus rigidis rectis ca. 7 mm. longis; floribus capite ovali in axillis pedunculatis, pedunculis pubescentibus ca. 7 mm. longis; corolla glabra viridi 5 mm. longa; calyce parvo: legumine sessili coriaceo plano curvato vel fere recto acuminato pubescente margine incrassato, 8-14 cm. longo, 1-1.2 cm. lato.

Collected near Tlacuiloltepec, No. 3869. Type, Herb. Univ. Calif., No. 137969.

***Acacia pueblensis* sp. nov.**

Frutex inermis, ramis fuscis pubescentibus: foliis pubescentibus 4-9-jugis, pinnis ca. 3 cm. longis; glandulis inter pinnas

parvis: foliolis 20–25-jugis oblongis acutis obliquis 3 mm. longis, 1 mm. latis: stipulis setaceis: spicis densis axillaribus fere sessilibus ca. 5 cm. longis: floribus flavido-albis sessilibus; corolla pubescente 2 cm. longa: legumine plano glabro ca. 15 cm. longo, 2 cm. lato, iis *Leucaenarum* simili; stipite 1 cm. longo.

Collected at Cerro de Solunte, No. 3863; Tlacuiloltepec, No. 3871; San Luis Tultitlanapa, No. 3193. Type, Herb. Univ. Calif., No. 136774.

***Mimosa hystricosa* sp. nov.**

Frutex aculeatus ca. 1 m. altus, ramis adultis glabris fuscis, novellis pubescentibus: aculeis sparsis recurvis copiosis ca. 5 mm. longis, basi 5 mm. latis: stipulis lineari-setaceis ca. 3 mm. longis: petiolo communi 1–2 cm. longo, rhachi 3 cm. longo, aculeis parvis armatis; pinnis 2–3-jugis, 1.5–2 cm. longis, rhachi setoso; foliolis ca. 6–jugis oblique oblongis acuminatis utrinque puberulis, ca. 5 mm. longis, 2 mm. latis: inflorescentia racemosa usque ad 8 cm. longa; pedunculis ca. 2 cm. longis; capitulis globosis diametro cum staminibus 2 cm.; corolla 4 mm. longa calyce duplo longiori; petalis 5 ad apicem cum macula purpurea notatis: staminibus 10: legumine fere recto; replo aculeis recurvis copiosis armato; valvis utrinque dense setosis in articulos tarde secedentibus.

Collected on Cerro del Gavilan and Cerro de la Yerba, No. 4242. Type, Herb. Univ. Calif., No. 136803.

***Dalea pueblensis* sp. nov.**

Annua erecta 1–2 dm. alta, caule ramoso purpureo glabro: foliis 1.5–2 cm. longis glabris; foliolis 3–4-jugis oblongis vel obovatis 3–4 mm. longis margine glandulosis, terminali 8 mm. longo: stipulis minutis subulatis: spicis oppositifoliis 4–8 cm. longis, floribus 10–15 laxè dispositis: bracteis ovatis longe acuminatis minute dentatis fuscis persistentibus, 2 mm. longis: pedicellis bracteis brevioribus: calyce 3 mm. longo glandulis parvis, costato; costis pilis erectis incurvis ciliatis; dentibus ovato-acuminatis: carina alisque 2 mm. longis purpureis vexillum superantibus: legumine pubescente 1-spermo, in calyce incluso.

Collected near Coxcatlan, No. 4146. Type, Herb. Univ. Calif., No. 134100.

***Phaseolus fulvus* sp. nov.**

Caulis tenuis volubilis e radice perenni, cum pilis longis flavidis patentibus vel reflexis hirsutus, simul parce tomentosus: petiolis 1.2–2 cm. longis hirsutis: foliolis late ovatis 2.5–3 cm. longis, 2–2.5 cm. latis, basi rotundatis vel paullum cuneatis, apice abrupte acuminatis, utrinque parce hirsutis; lateralibus inaequalibus, petiolulis ca. 1 mm. longis: stipulis obovatis striatis ciliatis 5 mm. longis: racemis 10–15 cm. longis, 5–10-floris; bracteis stipulis similibus: calyce ca. 3 mm. longo latoque, dentibus inferioribus brevibus deltoideis, superioribus fere usque ad apicem connatis: vexillo 1 cm. longo purpureo; carina alisque flavido-purpureis: legumine immaturo curvato 2 cm. longo, 4 mm. lato, villosa 5-spermo.

Collected on Cerro del Gavilan, No. 3889. Type, Herb. Univ. Calif., No. 137610.

***Lasiocarpus salicifolius* Liebmann.**

Vidensk. Meddel. 1853, p. 90. Walp. Ann., iv, 372.

This little known bush or tree was first collected in Oaxaca along the Rio de las Vueltas by Liebmann and since then no botanist seems to have met with it. Recently, however, Dr. C. A. Purpus has collected it several times in Puebla, near Oaxaca, and I have seen it growing abundantly in the vicinity of San Luis Tultitlanapa. The Puebla specimens have not been compared with the type, but they agree so closely with the very full description that there can be little doubt as to their identity. About San Luis it is a tree resembling the small oaks of the region. The flowers appear with or before the leaves and are dioecious, a character not noted by Liebmann and not possessed by any other Malpighiaceae plant. The anthers seem to be basifixed, although they are described "antherae dorso parum supra basim affixae." Before the carpels of the fruit separate and fall, the tree is a beautiful sight, the leaves are not full grown and are nearly hidden by the great abundance of the

long purple hairs of the fruit. The different shades of dark purple and yellowish purple covering the trees, each tree having its own color, are conspicuous and interesting on the mountain slopes. Nos. 4244-4247. Herb. Univ. Calif., Nos. 134106-134109.

***Polygala Purpusii* sp. nov.**

Fruticulus, caules ramosi ca. 15 cm. alti cinereo-pubescentes: foliis alternis pubescentibus, inferioribus obovatis apiculatis in petiolum brevem attenuatis ca. 15 mm. longis, 7 mm. latis; superioribus brevioribus pubescentioribus acuminatis: floribus roseis in racemos bracteatos 4-6 cm. longos, ramos terminantibus dispositis: sepalo supero viridi persistente margine roseo; alis oblongo-ovatis inaequalibus 4 mm. longis, 2 mm. latis, petalis superioribus longioribus: carina ecrestata flava: bracteis ovato-lanceolatis pedicellis aequantibus: capsula pendula orbiculari pubescente emarginata: seminibus sericeo-pubescentibus; arillo albo alte lobato semini medio aequilongo.

The yellow keel is crestless, the other petals and the sepals except the persistent one are rose colored and deciduous. Collected on hills near Acatitlan, No. 3922. Type, Herb. Univ. Calif., No. 137723.

***Jatropha rufescens* sp. nov.**

Frutex 2 m. altus ramosus dioicus, ramis juvenibus diametro 6-8 mm., fusco- vel albo-tomentosis: foliis orbicularibus vel late ovatis cordatis, margine paullum lobatis, majoribus 12 cm. longis latisque, supra viridibus ad venas fusco-pubescentibus, subtus dense tomentosis ad venas fuscis; petiolis usque ad 8 cm. longis; stipulis cito deciduis lanceolatis basi 3 mm. latis ca. 1 cm. longis; cymis masculis foliis brevioribus, bracteis lineari-lanceolatis 2 mm. longis; calycis laciniis orbicularibus fere glabris diametro 2 mm.; corollis urceolatis 6 mm. longis, lobis ca. 2 mm. longis, glandulis orbiculatis fere sessilibus; staminibus 10, filamentis interioribus infra medium connatis: floribus femineis mari similibus, stylis basi connatis 2-fidis: capsulis 2.5 cm. latis, pedunculis ca. 13 mm. longis.

Collected at Tlacuiloltepec, No. 4049. Type, Herb. Univ. Calif., No. 134437.

***Manihot pauciflora* sp. nov.**

Frutex glaber ramosus 2-3 m. altus, cortice fusco-castaneo: foliis trisectis, laciniis petiolulatis late cuneatis retusis apiculatis ca. 15 mm. longis, 12 mm. latis, terminali multo majore; petiolis 2 cm. longis: floribus 1-2 ramos breves terminantibus flavido-albis: calyce masculino 2-5 cm. longo, lobis 1.5 cm. longis; pedunculo ca. 2 cm. longo, basi minutim bracteato; staminibus lobis brevioribus: flore femineo mari simili aposepalo, segmentis cito singulatimque deciduis; stylis basi connatis apice dilatatis lobatisque: capsulis diametro 18 mm.; seminibus ovoideis albo-striatis 1 cm. longis.

The leaves resemble those of *Trifolium*. The short 1-2-flowered racemes and the distinct sepals of the pistillate flower are peculiar. Collected at Santa Lucia, No. 3418. Type, Herb. Univ. Calif., No. 131175.

***Daphnopsis Purpusii* sp. nov.**

Frutex ramosus, ramis fuscis glabris, juventute albo-tomentosis: foliis oblongo-ovatis acuminatis vel obtusis basi attenuatis supra parce subtus dense tomentosis, 2-3 cm. longis, 9-12 mm. latis: floribus masculis cymoso-paniculatis ramulos terminantibus; pedunculis 3-8 mm. longis pubescentibus; pedicellis fere nullis: perianthii tubo pubescente tenui, 8 mm. longo, lobis 2 mm. longis, intus pubescentibus: fructu ovoideo, 6 mm. longo. Flores femineos non vidimus.

Collected on Cerro de Paxtle, No. 4116. Type, Herb. Univ. Calif., No. 136842.

***Cuphea trichandra* sp. nov.**

Annua, caulibus strictis saepe ramosis 15-20 cm. altis retrorsum pubescentibus, superne scabrido-hirsutis glandulosis simul minute pubescentibus: foliis ovatis vel lineari-lanceolatis usque ad 3 cm. longis, 5 mm. latis, strigoso-scabriusculis, margine ciliolatis; infimis petiolis 8 mm. longis, ceteris sessilibus: racemis simplicibus inferne foliatis: calyce ampullaceo purpureo hirsuto breviter calcarato, lobo dorsali maximo producto; disco crasso

deflexo: ovulis ca. 6: petalis 2 dorsalibus intense violaceis obovatis unguiculatis 8 mm. longis, infra squamis 2 luteis; ventralibus 4 subalbidis oblongis 3 mm. longis: staminibus longioribus subexsertis: filamentis fere ad antheras dense albo-lanatis.

This species is apparently near *C. laminuligera* Koehne. Collected at Tres Mogotes, No. 4015. Type, Herb. Univ. Calif., No. 131045.

Fraxinus Purpusii sp. nov.

Arbusecula cortice fusco-cinereo undique glabra: foliis supra viridibus nitidis subtus pallidioribus punctatis, 6–8 cm. longis: foliolis 5 ovato-lanceolatis utrinque attenuatis acute serratis 3–5 cm. longis, 10–12 mm. latis, sessilibus, terminali majori basi longe angustato: floribus polygamis apetalis; paniculis 1–1.5 cm. longis; calycibus cupulatis 1 mm. longis irregulariter dentatis; antheris 1–3 filamentis aequilongis: samaris oblongis 2 cm. longis, pedicellis 5–12 mm. longis, alis apice emarginatis.

Collected at San Simon, No. 3990, and Cerro de Paxtle, No. 2600. It grows also about San Luis Tultitlanapa. Types, Herb. Univ. Calif., Nos. 131138, 131139.

Ilex socorroensis sp. nov.

Glabra cortice fusco striato: foliis obovatis apice rotundatis basi in petiolum brevem angustatis crenato-dentatis supra nitidis subtus pallidioribus coriaceis venosis, 3–5 cm. longis, 2–3.2 cm. latis: calycibus cupulatis, lobis deltoideis: corollae tubo brevi; antheris lobis brevioribus: drupis oblongis cum stylo brevi conico apiculatis; pedicellis 6 mm. longis: seminibus 4–5.

The description is drawn from a fruiting specimen which has a few fragments of flowers attached. Collected on Socorro Island by F. E. Barkelew with the California Academy of Science Expedition of 1903. Type, Herb. Univ. Calif., No. 136719.

Philibertia tomentella sp. nov.

Volubilis caulibus pubescentibus: foliis orbicularibus vel late ovatis abrupte apiculatis cordatis sinu fere clauso, supra puberulis subtus pubescentibus, 6–8 cm. longis, 4–5 cm. latis; petiolo

ca. 12 mm. longo pubescente: umbellis ca. 12-floris; pedunculis ca. 4.5 cm. longis puberulis; pedicellis pubescentibus 3 cm. longis: floribus albis: calyce fere ad basim in lobos acuminatos ciliatos extus pubescentes, 8 mm. longos, secto: corona undulata: folliculis ovato-acuminatis, 7 cm. longis, 2.5 cm. latis levibus.

Collected by T. S. Brandegee in the Cape Region of Baja California at San Jose del Cabo and Miraflores. This species climbs high among the bushes bordering the trails of the region. No. 361 distributed as *P. Palmeri*. Type, Herb. Univ. Calif., No. 105441.

Vincetoxicum (Gonolobus) pueblense sp. nov.

Volubile, caulibus puberulis hirsutulisque superne cum pilis reflexis hirsutis: foliis oblongis longe acuminatis cordatis supra viridioribus hirsutulis subtus hirsutis, ca. 5 cm. longis, 2.5 cm. latis; petiolis hirsutis ca. 3 cm. longis: cymis laxe 6-10-floris; pedunculis ca. 1 cm. longis; pedicellis ca. 6 mm. longis; bracteis linearibus: calyce fere ad basim 5-secto, lobis lineari-lanceolatis ca. 3 mm. longis hirsutulis: corolla flavo-fusca striata campanulata, lobis lanceolatis extus hirsutulis: corona basi tubi staminei affixa annuliformi, lobis 5 fuscis subglobosis rugosis carnis: columna brevissima: stigmate plano radiante: folliculi desunt.

Collected near Tlacuilosto and San Luis Tultitlanapa, not in sufficient quantity for distribution, No. 4064. Type, Herb. Univ. Calif., No. 131328.

Amphorella gen. nov. Asclepiadacearum.

Calyx 5-partitus, basi intus 5-glandulosus. Corolla urceolata, tubo globoso ad faucem constricto, lobis 5. Coronae squamae 5, carnosae imae basi columnae affixae, medio tubi corollae adnatae membrana hyalina connatae, apice liberae acuminatae margine involutae. Columna brevissima; antherae membrana minuta terminatae. Pollinia in quoque loculo solitaria parva oblonga horizontalia. Stigma medio vertice umbonatum. Folliculi leves deflexi. Herba perennis erecta hirsuta. Folia opposita.

***Amphorella castanea* sp. nov.**

Herbacea caulibus strictis basi ramosis e radice lignosis, ca. 2 dm. altis: foliis ovato-acuminatis oppositis ca. 15 mm. longis, 12 mm. latis; petiolis 1–2 mm. longis: umbellis 3–4-floris, pedunculis brevissimis basi bracteatis, bracteis 3 mm. longis filiformibus pedicellis longioribus: corollae luridae tubo calyci aequilongo, lobis lanceolatis 4 mm. longis: coronae squamis tubo aequilongis.

The scales of the corona are attached to the short staminal column and adnate to the globular tube of the corolla about to the middle, the free portion surpassing the tube; the adnate parts are connected by a membrane free from the tube. The gyno-androecium is small for the size of the flower and the caudicles are very short. Collected at Tlacuilopec, No. 4243. Type, Herb. Univ. Calif., No. 125890.

***Pherotrichis mixteca* sp. nov.**

Herbacea erecta ca. 3 dm. alta undique hirsuta: foliis oppositis oblongo-lanceolatis 6 cm. longis, 1.5 cm. latis; petiolis 1 mm. longis: umbellis ad axillas sessilibus 3–6-floris: pedicellis ca. 7 mm. longis: calycis segmentis 3 mm. longis ovato-acuminatis basi intus 10-glandulosis: corolla campanulata ad medium 5-lobata lurida venosaeque; lobis intus albo-lanatis, acuminatis calycem superantibus: coronae squamis quadratis carnis planis apice lunatis basi columnae affixis antheras superantibus: columna brevissima: antheris cum membrana hyalina minuta instructis: pollinia ovata obliqua: stigmatibus rostrato, umbone cylindraco gyno-androecio aequilongo apice bilobo concavoque. Folliculi ignoti.

A few specimens were collected on Cerro Verde, Oaxaca, No. 4241. Type, Herb. Univ. Calif., No. 136812.

***Laurentia pinetorum* sp. nov.**

Annua, caulibus 5–12 cm. altis erectis puberulis: foliis imis parvis ovatis sessilibus serratis, ceteris lineari-lanceolatis serratis usque ad 2 cm. longis: floribus 2–5 racemosis; pedicellis ca. 1 cm.

longis; calycis tubo turbinato, segmentis lineari-lanceolatis 2 mm. longis; corolla tenui 5 mm. longa, limbo caeruleo, lobis inferioribus 3 oblongo-acuminatis, superioribus linearibus erectis: filamentis capsula accreta disjunctis: antheris 2 minoribus parce penicillatis.

This small plant is technically a *Palmerella* and nearly related to *P. tenera* Gray, but following the conclusion of Schönland it is described as a *Laurentia*. It is a smaller plant than its close relative and has a different corolla. Collected on dry sandy soil among pine forests at base of Popocateptl, No. 3665. Type, Herb. Univ. Calif., No. 131022.

***Barroetia laxiflora* sp. nov.**

Annua, 4-6 dm. alta, caulibus purpureis puberulis, basi ramosis; foliis inferioribus oppositis late ovato-acuminatis cordatis, in petiolum cuneatis, fere glabris, subtus resinoso-atomiferis, duplo crenato-dentatis dentibus saepe breviter mucronatis; lamina ca. 5 cm. longa, 4 cm. lata; petiolo 1-2 cm. longo: capitulis laxe paniculatis; bracteis alternis margine setosis: involucri squamis exterioribus brevibus, interioribus 8 mm. longis, lineari-acuminatis striatis, floribus 15-20 aequilongis; pedicellis 5-12 mm. longis: acheniis uno latere 1- altero 2-nervato: pappo achenio brevior.

This species differs from *B. subuligera* in having an annual root. It resembles closely an annual species collected in Sinaloa. Collected at Coxcatlan, No. 4128. Type, Herb. Univ. Calif., No. 136797.

***Gymnolomia scaposa* sp. nov.**

Herba perennis, foliis 10-20 radicalibus parce hirsutis reticulatis inter se valde dissimilibus; nunc laminis 4 cm. longis, 2.2 cm. latis, basi cordatis vel cuneatis margine crenato-dentatis; nunc angustissimis lobis 2 lateralibus oblongis ca. 1 cm. longis, terminalique parvo longe remoto late ovato: petiolis alatis ca. 4 cm. longis: scapis ca. 3 dm. altis parce hispido-hirsutis, bracteis linearibus: capitulis 1-3, pedunculis 4-8 cm. longis: involucri squamis lanceolatis, exterioribus longioribus disco aequantibus:

radii floribus neutris flavis 1.3 cm. longis, disci 5 mm. longis, tubo brevi, limbo cylindraceo: radii achaeniis vacuis, disci calvis 4 mm. longis obtuse 4-angulatis: paleis acuminatis; receptaculo convexo.

This species has the habit of *Balsamorhiza*, but the ray akenes are those of *Gymnolomia*. It is very unlike the other species of its genus. Each specimen has its own peculiar form of leaf. The extreme variations are: an ovate-cordate blade with broadly winged petioles or a blade as narrow as the winged petiole with a pair of lobes at its base and a small ovate terminal lamina. The blade and petiole might be considered as forming an almost sessile leaf. Collected in oak forests near Coxcatlan, No. 4120. Type, Herb. Univ. Calif., No. 136841.

***Aspilia hispida* sp. nov.**

Caules purpurei parce pubescentes: foliis oppositis ovatis longe acuminatis serratis strigoso-pilosis ca. 2.5 cm. longis, 1.2 cm. latis: capitulis ad apices ramorum subcorymbosis, 5 mm. altis latisque; pedicellis 2.5 mm. longis, strigosis: involucri squamis 2-3-seriatis, interioribus 5 mm. longis, quam exterioribus longioribus: radii floribus flavis neutris 4 mm. longis, disci 6 mm. longis angustis, limbo paullum ampliato: acheniis maturis obtuse 4-angulatis 2 mm. longis, cum pilis erectis appressis sericeo-hirsutis: pappo nunc ex aristis paucis deciduis squamellisque intermediis, nunc e squamellis solis: paleis acuminatis striatis: receptaculo convexo.

Collected at Coxcatlan; No. 4126. Type, Herb. Univ. Calif., No. 136814.

***Melampodium aureum* sp. nov.**

Herbae perennes verisimiliter; ramis subterraneis conjunctis, erectae paululum ramosae: caulibus hirsutis usque ad 1 dm. altis: foliis spathulatis vel ovatis hirsutulis obtusis vel acutis, margine integris vel paullum dentatis, 2-3 cm. longis, 1-1.5 cm. latis; petiolis late alatis basi connatis; pedunculis ca. 4 cm. longis: involuero scutellaeformi alte 5-lobato, lobis orbicularibus obtuse acuminatis margine scariosis: radiis ligulatis aureis 11 mm.

longis, 2 mm. latis, apice obtusis: bracteis radiorum achenia involutis costatis paullum tuberculatis: acheniis incurvatis cum stylis corollisque e medio orientibus.

Each of the numerous specimens bears only a single flower, but many of them have young branches growing from the upper axils that later will produce more flowers. The subterranean stems are 12 cm. long and none of them connect two plants, a condition due probably to the negligence of the collector. The fruit has stout marginal ribs together with one central on the back and one on each side. Collected at Cerro del Gavilan and Cerro del Oro, No. 3822. Type, Herb. Univ. Calif., No. 133322.

***Cacalia Purpusii* Greenman, n. sp.**

Perennis herbacea erecta; caule 3.5 dm. alto simplici subnudo striato hirtello-puberulento; foliis radicalibus petiolatis ovato-oblongis vel ellipticis 1.5–3.5 cm. longis 1–3 cm. latis inaequaliter dentatis utrinque parce pubescentibus, dentibus subcartilagineis; petiolis 2.5–5 cm. longis; inflorescentia corymbosa paucicapitata sublanato-tomentosa; bracteis bracteolisque lineari-attenuatis; capitulis 12–15 circiter 1 cm. longis 10-floris; involucri squamis 8 lanceolatis vel lanceolato-oblongis 6–7 mm. longis acutis vel obtusis glabris plus minusve purpurascens; corollis albidis profunde 5-lobatis; pappi setis copiosis sordidis tubum corollae subaequantibus; acheniis cylindricis striatis glabris.

This species is apparently most nearly related to *Cacalia Goldsmithii* Rob., from which it differs in size, foliar characters, pubescent stem and leaves, and sublanate fewer-headed inflorescence. Collected at Cacalote, State of Puebla, Mexico, August, 1909, *C. A. Purpus*, No. 3845. Type, Herb. Field Museum; co-type, Herb. Univ. Calif., No. 125891.

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LEUVENIA, A NEW GENUS OF
FLAGELLATES.

BY
NATHANIEL LYON GARDNER.

Leuvenia gen. nov.

Status cognitae triplices:—*St. mobilis*, zoosporis pyriformibus, uninucleatis; chromatophoris duo, ovoideis, lente curvatis, atroviridibus, ad polum anticum locatis, biellatis; ciliis inequalibus, longiori reflexo; primum agilibus, admodum retarde moventibus, amoeboidisque et vacuolis duo contractilibus indutis, altera anteriori altera posteriori; pyrenoidibus, gula, stigmatique desinentibus. *St. augescens et immobilis*, zoosporis restantibus natantibusque ad superficiem aquae, formam sphericam assumptibus, ciliis retractantibus, vacuolis non contractantibus, in magnitudine augescentibus demum multinucleatis (ad 20); chromatophoris constrictionibus divisis et per filis protoplasmaticis gracilibus longe connectis; magnitudine formaque irregularibus: *St. palmelloidea* statibus immobilibus per gelinis copiosis exeretis passim adherantibus in massis funestoideis, frequenter in magnitudine augescentibus formam late pyriformem assumptibusque.

Statibus immobilibus palmelloideisque zoosporas emittentibus sive per divisionem protoplasmatis ut zoosporis uninucleatis et chromatophoris geminatis aut sive per protoplasma indivisum expellantibus ut zoosporis multinucleatis et chromatophoris multis.

Reproductio sexualis adhuc incognita.

Leuvenia natans sp. nov.

Zoosporis uninucleatis 4-6 μ in diam., zoosporis multinucleatis in diam. variis. Cellulis immobilibus maturis sphericis, 20-24 μ in diam. Cellulis immobilibus late pyriformibus 40-45 μ in diam.

Leuvenia gen. nov.

Three stages are known :

The Motile Stage.

Zoospores at first pear-shaped, containing a single nucleus and two ovoid, slightly curved, dark green chromatophores located near the anterior end at which two cilia arise, a long one pointing forward and a short one pointing backward, moving rapidly when first liberated, retarding their motion and becoming amoeboid toward the close of the motile period, when two contractile vacuoles appear, one at the anterior end and one at the posterior end; pyrenoids, gullet, and stigma absent.

The Growth Stage.

Zoospores on coming to rest float to the surface of water, become spherical, withdraw their cilia, the contractile vacuoles cease to pulsate, cell walls develop, rapid increase in size takes place, the nuclei increase to as many as 20, the chromatophores divide by a constriction process, remaining attached to each other for some time by means of delicate protoplasmic strands and are irregular in shape and size.

The Palmella Stage.

Under certain conditions these organisms secrete a gelatinous substance causing them to adhere together in stringy masses in which they may increase in size and become balloon shaped by unequal growth; asexual reproduction by 2-ciliate zoospores arising by the division of the cell contents of either the palmella or the growth stages, or the whole protoplast, in a young stage, may develop into a single zoospore. Sexual reproduction unknown.

***Leuvenia natans* sp. nov.**

Zoospores with a single nucleus $4-6\mu$ in diameter, larger zoospores variable in size; mature spherical cells $20-24\mu$ in diameter; balloon shaped cells $40-45\mu$ in diameter. Otherwise as the character of the genus.

Leuvenia natans was distributed in Collins, Holden and Setchell, Phycotheca Boreali Americana, as number 1380, under *Osterhoutia natans* Gardner (nomen nudum). This is the co-type material. The type number is 1587 in the herbarium of N. L. Gardner. The name *Osterhoutia natans* has recently been published from this material by N. Wille in the Nachträge zum I Teil, 2 Abt., p. 91, 1909, of Engler and Prantl, Die Natürlichen Pflanzenfamilien; but the description is very brief and incomplete. Since the distribution of the material it has been learned that the name *Osterhoutia* had been previously used for a genus of flowering plants, hence it seems best to change the name, and I propose *Leuvenia*, from Leuven, one of Professor Osterhout's given names.

This interesting organism was discovered on the surface of quiet, fresh water in a shaded ravine emptying into Lake Temescal, Oakland, California, by Professor W. J. Van Leuven Osterhout. I also recently found specimens in great abundance floating on the surface of small pools of water highly charged with organic matter near the stables at the Presidio, San Francisco, California. Some of the material from the first mentioned locality was brought into the botanical laboratory of the University of California on several different occasions for the purpose of studying phases of its development, in addition to the observation and study made upon it in its native habitat.

The results of an incomplete study are here given, but many other facts would doubtless be discovered upon further investigation, the work by no means being intended to be exhaustive.

THE MOTILE STAGE.

The organisms in this condition are exceedingly small, being but $4-6$ micromillimeters in diameter. When they are first liberated, they are more or less pear-shaped with the larger end

pointing in the direction of movement forward. (Plate 14, fig. 1.) They move about quite rapidly during the first hour succeeding their liberation, after which they begin to retard their motion and finally come to rest. During the latter part of the motile stage they become actively amoeboid in habit and assume a great diversity of forms, some of which are illustrated in Plate 14, figs. 2-5; and finally, on coming to rest, they withdraw the two unequal cilia, assume a spherical shape, usually float to the surface of the water and rapidly develop a cell wall. During the latter part of the motile stage two contractile vacuoles appear, one at the anterior end and one at the posterior end, which pulsate for a brief period only. (Plate 14, fig. 5.) There are two cilia, unequal in length, arising directly from the smooth surface at the anterior end, a long one pointing forward and a short one pointing backward. The typical zoospore has but two oval-shaped chromatophores, green in color, about twice as broad as long, sometimes slightly curved outward, but usually flattened on the inner side and convex on the outer side. Each spore has but a single nucleus. There is no stigma at any stage of the development thus far observed, notwithstanding that the presence of such an organ is so common in organisms similar to this one. Likewise there is no gullet at any stage of the development.

There are some very interesting problems which seem to be physiologically connected with the origin of the motile stage or production of zoospores.

These organisms in the resting stage are found at the surface of the water in various stages of development. In this condition the upper surface seems to be quite dry and acts toward water as though it were oily. Great masses may be pushed aside with the hand and upon being released will immediately draw back and cover the original surface. They are not readily miscible with water and considerable agitation is required to cause them to become wet.

Experiments in the laboratory seem to show that they must be submerged and wet in order to induce them to break up into the swarm stage. In nature they probably remain on the surface for some time until agitated in some way, perhaps by

the wind or by rain, causing them to become wet, after which they sink. Rather vigorous agitation will, however, cause them to become wet as shown by experiment, after which they do sink. Experiments in the laboratory also show that when they do thus become wet, preparation for the motile stage begins. Material was brought into the laboratory on several different occasions, thoroughly shaken in a vessel with water and caused to become wet. In no case was it possible to induce the motile stage to appear without allowing the wet material to stand over night at least. Length of time did not seem to be the governing factor in determining the appearance of the zoospore stage, for if material treated in the same way was allowed to stand in the light for the same length of time, or even a greater length of time, very little, if any, change would take place. In material prepared and allowed to remain over night the swarming period could be delayed for several hours on the next morning by keeping it in the dark; otherwise, vast numbers of spores usually appeared about 8 o'clock in the morning.

The phase of the life-cycle above mentioned was but rarely observed while the organisms were in their native habitat, and when so found the time was always in the early part of the day. The material, consisting of a vast number of individuals of various ages and sizes, was always collected while floating at the surface of the water, and no special attempt was made to collect from beneath the surface. Collections were always made by skimming off the surface. As has already been shown, experiments indicate that the motile stage is induced only in the morning with the appearance of sunlight. While in this stage they may course through the water far beneath the surface. This may account for the seeming absence of the organisms in the motile stage in their native habitat.

The number of times that the organisms may be made to go into the swarm stage without a period of rest has not been determined definitely. The process has been repeated in the laboratory as many as four times, each at intervals of several days.

The character of the zoospores may be somewhat regulated by the frequency with which the floating material is shaken and

caused to sink beneath the surface of the water. When once stranded at the surface they develop quite rapidly and within a period of thirty hours usually possess several chromatophores and nuclei. If caused to become wet at this stage it has been noted that the whole organism may go immediately into the zoospore stage without dividing. See plate 14, figs. 7 and 8. These forms go through the same cycle as that previously described for the smaller zoospores.

THE GROWTH STAGE.

Immediately upon coming to rest, increase in size and differentiation begins. The nucleus divides and redivides in quite rapid succession until as many as twenty nuclei appear. These are located beneath the chromatophores near the center of the cell. The behavior of the chromatophores in division is rather unusual. They appear as though they were quite plastic and in division simply elongate, become more and more constricted in the middle as well as more and more transparent in the constricted area, until finally there is but a delicate strand of clear protoplasm remaining between them. This process is repeated rapidly until the maturity of the organism is reached, at which time all the new chromatophores arising from each of the original pair are connected into a network as shown in Plate 14, figs. 9 and 10. It has not been ascertained how long these connections may remain, but probably not over ten to fifteen days if the organism is allowed to remain at the surface or not caused to go into the motile stage; however, a much shorter period of time will suffice to destroy the connection if they are induced to go into the motile stage.

The number of chromatophores varies considerably in different individuals of the same age, but when the individuals break up into the motile stage there are just as many spores formed as there are nuclei and each spore receives two chromatophores. Fig. 11, Plate 14, represents a median section through a mature organism in preparation for the swarming stage. The chromatophores are arranged radially around the periphery and a nucleus is situated near the inner end of each pair of chro-

matophores. The whole interior is now divided up into zoospores, each appropriating two chromatophores and one nucleus, and are free to move about for some time within the mother cell wall, after which they escape through an opening in the wall. In no case has any variation in this method of bringing about the motile stage been noted except the one stated above, viz., that sometimes if the organism is young, possessing only a few chromatophores and nuclei, the whole protoplast becomes biciliated, breaks through the mother cell-wall and becomes motile. Such organisms have been noted with as many as eight chromatophores.

THE PALMELLA STAGE.

On one occasion some material was found in rather small, somewhat lacerated strands floating at the surface of a tiny stream. The material in this condition is represented by fig. 12, Plate 14. Upon examination the material was found to contain a large number of the organisms under consideration embedded in a rather soft gelatinous matrix which stained very readily in methylene blue. Fig. 13, Plate 14, shows a few of the organisms in this condition.

In this condition the organisms are at first spherical, but soon become balloon-shape by unequal growths. Fig. 10, Plate 14, represents such a condition with the smaller end of the cell still encased in what seems to be a remnant of an original cell wall, which was unable to keep up with the rapid expansion of the growing protoplast.

THE SYSTEMATIC POSITION.

The somewhat unusual combination of morphological features which this organism possesses, such as the inconstant number of nuclei and chromatophores in growth and mature stages, the presence of contractile vacuoles in the anterior and in the posterior ends in the motile stage, the method of chromatophore division, and the absence of such organs as pyrenoids, gullet, and stigma, makes its systematic position rather difficult to determine.

Its method of nutrition seems to be holophytic.

I forego any attempt at present to classify it, even to naming the family to which it belongs or in which it has its nearest affinities.

In conclusion I wish to acknowledge my grateful appreciation for the help I received in the preparation of this paper from Professor W. A. Setchell, who rendered the Latin diagnosis.

PLATE 14.

Figs. 1-13.—*Leuvenia natans* Gardner gen. et sp. nov.

1.—A zoospore soon after being released.

2-5.—Later stages of zoospores showing the amoeboid habit.

5.—A zoospore coming to rest showing contractile vacuoles at the anterior and at the posterior ends.

6.—A resting zoospore or a young plant with the cilia withdrawn and with a cell wall developed. Figs. 1-6 each have but two chromatophores.

7.—A motile stage with eight elongated chromatophores.

8.—A motile stage with four chromatophores.

9.—A free floating individual plant showing the rapidly dividing chromatophores held together by delicate protoplasmic threads.

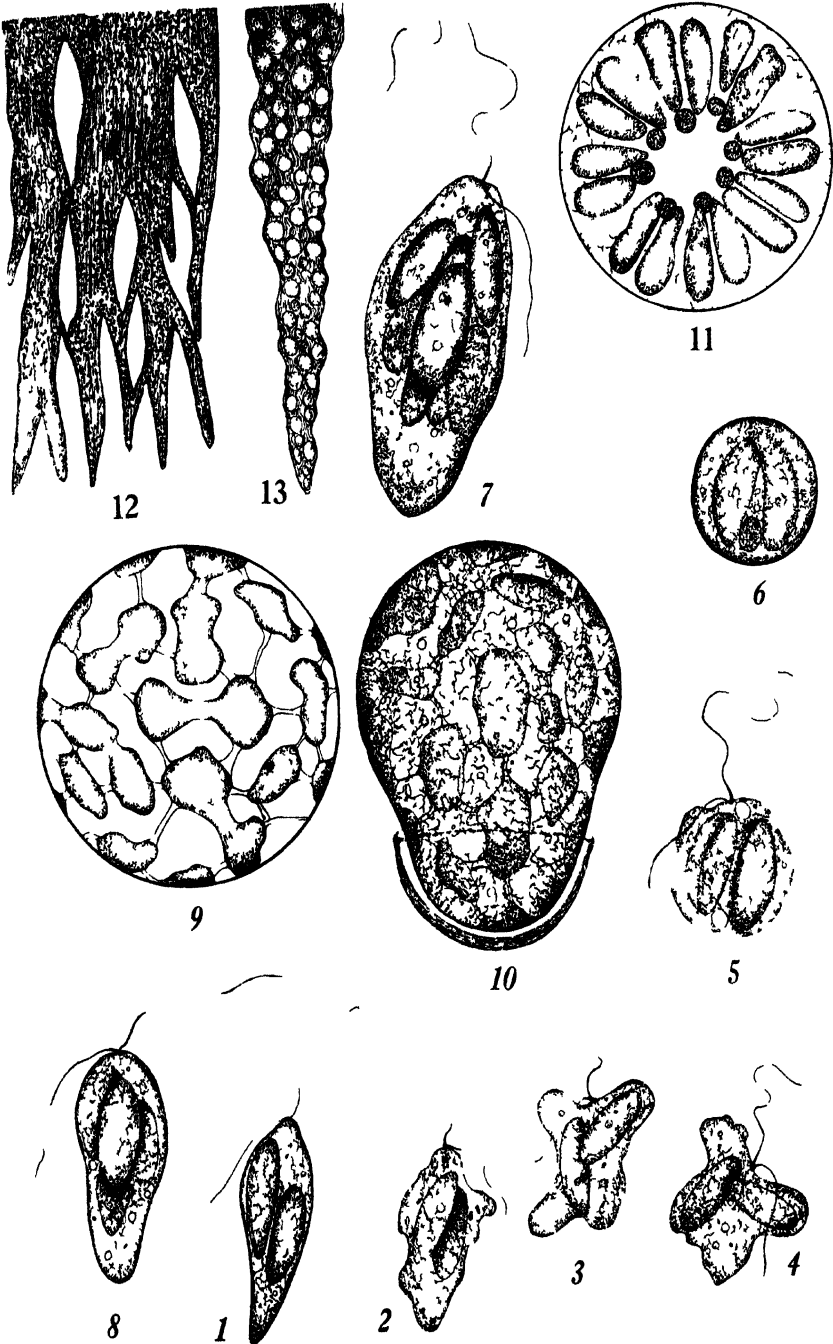
10.—A plant held within jelly and the upper part enlarged.

11.—A section through the center of a plant showing the nuclei and the chromatophores arranged radially in pairs.

12.—A habit sketch of the margin of a floating gelatinous mass.

13.—The same as fig. 12 more highly magnified, showing the individual plants embedded within the jelly.

All highly magnified.



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May 26, 1910

THE GENUS SPHAEROSOMA.

BY

WILLIAM ALBERT SETCHELL.

In February, 1903, Dr. N. L. Gardner found growing under a deposit of Eucalyptus leaves on the campus of the University of California at Berkeley, a number of specimens of a small, fleshy fungus of a light brown color. In general it seemed to belong to the genus *Sphaerosoma* but it did not correspond to the description of any of the species described under that genus. It was submitted later, along with other hypogaeous fungi, to Professor Eduard Fischer of Bern, who also expressed the opinion that it was to be considered new.

On the assumption of its being a new species, the writer has made some study of the plant from time to time, examining the literature and finding certain contradictory statements and conflicting ideas, and was just about to send off a paper for publication when he became aware that Rouppert had been going over the same ground and had published his results a few months before. (Bull. Acad. Sci. Cracovie, June, 1909.) Through the kindness of the California Academy of Sciences, he was able to consult this paper. At first it seemed that Rouppert, through examination of authentic material, had been able to settle some of the more doubtful questions; but a more careful study of his paper leaves the writer still in doubt and inclined toward certain views quite at variance with those of Rouppert. These, together with the reasons for the same, the writer hopes to set forth in the following pages.

It seems best, although Rouppert (1909) and Seaver (1905) have both done so, to outline the principal references to this genus and its various species.

The genus *Sphaerosoma*, with *Sphaerosoma fuscescens* as its type species, was founded by Klotzsch (1839) upon specimens collected by himself in autumn in Grünewald and others collected in the Botanical Garden near Berlin by Carl Bouché.

The figures of Klotzsch show a *Peziza*-like plant, with broad base of attachment, expanded hymenium having asci containing eight colorless echinulate spores and paraphyses with decidedly swollen tips and projecting only moderately beyond the asci. In 1842, Corda (1842, 1842a) also illustrated and described *Sphaerosoma fuscescens*, creating for it a new genus *Sphaerosoma*.

Tulasne (1851) described a second species, *Sphaerosoma ostiolatum*, type found near Paris, and other specimens from Bristol already noted (under Tulasne's manuscript name) by Berkeley and Broome (1851). Tulasne's drawings represent a plant of tuberoid appearance, cerebrally convolute, hollow, opening by a broad apical pore, and clothed completely externally by the hymenium. The mode of attachment is not certain from the drawing, but is described as being by a broad base with copious mycelium. The asci contain eight globular, brown and bluntly tuberculate spores. The paraphyses are moderately swollen at the tip and project considerably beyond the asci. Tulasne also says that, in a small specimen of *Sph. fuscescens* received from Berkeley, to whom it had been sent by Klotzsch, the spherical spores were reticulate-echinate and less brown than in *Sph. ostiolatum*.

Zobel in the sixth volume of Corda's *Icones Fungorum* (1854) figures and describes both species, retaining the *Sphaerosoma* of Corda for *Sph. fuscescens* and creating a new genus *Sphaerozone* for *Sph. ostiolatum*, which he calls *Sphaerozone Tulasnei* Zobel. He avers that neither in Corda's *Anleitung* (1842) nor in the sketches which Corda left, is there any indication of the spores being reticulate-echinate. At the same time, the figures on plate XI show the plant called *Sphaerosoma fuscescens* by Corda and Zobel to be stalked, hollow, with para-

physes decidedly longer than the asci, and with the spores regularly and bluntly tuberculate. The description, however, states that this species is solid and provided, at times, with a short stipe.

In 1885 Hesse described a plant from the vicinity of Marburg, Austria, to which he gave the name *Sphaerosoma fragile*. The affinities are closely with the *Sph. ostiolatum* of Tulasne. It is hollow, but not necessarily with apical pore, paraphyses much longer than the asci, and brown, bluntly tuberculate spores.

In 1896 Rehm stated that he had not seen a specimen of *Sph. fuscescens*, but quoted Magnus to the effect that the spores are irregular, angular, warted and colorless, 19-25 μ in diameter. Professor Magnus has kindly informed me that he found a single specimen which was consumed in his study of it and that he can add nothing to the above. The warted character of the spore points to *Sph. ostiolatum* but the mature spores in that species are fuscous.

Schroeter (1897) states the characters of the genus, credits it with having three species, and says that the spores of *Sph. fuscescens* Klotzsch are globular, dark brown, and coarsely blunt-warted. He also reproduces Tulasne's figures of *Sph. ostiolatum* and thereby seems to refer *Sph. ostiolatum* under *Sph. fuscescens*. Yet he still mentions three species under the genus, all that had been described up to that time.

In 1903 Hennings described, from a single specimen, a plant considered by himself to be closely related to *Sphaerosoma*, under the name *Ruhlandiella berolinensis*. This fungus was found in the greenhouses at the Botanical Gardens of Berlin growing on the earth of flower-pots containing *Melaleuca*. It is described as spherical, attached at the base by mycelial strands, having the hymenium covering the entire surface (except at the point of attachment) and composed of slender paraphyses scarcely at all swollen at the tip and hardly if at all longer than the asci, while the spores are globular, slightly brownish at maturity and reticulate-verrucose.

In 1905 Seaver described from the neighborhood of Iowa City, Iowa, U. S. A., a plant which occurred in abundance on damp soil, but not hypogaeous, under the name of *Sphaerosoma*

echinulatum. This plant is said to have a considerable sterile base attached by delicate hyphae from a broad basal area, and with the hymenium consisting of paraphyses projecting only moderately beyond the asci, which contain globular colorless spores adorned at maturity with comparatively long spines.

In 1905 Rehm distributed in his *Ascomycetes Exsiccatae* (Fasc. XXXV, no. 1601) and mentioned in the *Annales Mycologici* (1905a, p. 409), a plant from upper Silesia which he refers also to *Sph. echinulatum* Seaver. Through the kindness of Professor W. G. Farlow I have been able to examine a fragment from this distribution.

In 1908 Rouppert published the description of a new species, *Sphaerosoma Janczewskianum*, from Poland and in the succeeding year (1908) followed this by a review of the genus, stating the generic characters, revising the species and synonymy, and discussing its probable affinities.

According to Rouppert, there are to be recognized four species as belonging to *Sphaerosoma*, one of which has reticulate spores, one verrucose spores, while the third and fourth have echinate spores. He comes to the conclusion that the species with reticulate spores is *Sph. fuscescens* Kl. and refers the *Ruhlandiella brolinensis* Henn. to it as a synonym.

The verrucose-spored species is *Sph. ostiolatum* Tul., under which Rouppert refers *Sph. fragile* Hesse and suggests that Schroeter's references (cf. above, 1897) to *Sph. fuscescens* belong there also.

The two echinate-spored species are *Sph. echinulatum* Seaver (both as to American and European specimens) and *Sph. Janczewskianum* Rouppert.

In undertaking any examination of this genus, it will at once become apparent that the status of the type of the genus, viz., *Sphaerosoma fuscescens* Klotzsch, is in a most unsatisfactory condition. Klotzsch's figures and description point to a plant with short paraphyses which are swollen at the tips and with echinulate spores. This suggests that the plants described under *Sph. echinulatum* or *Sph. Janczewskianum* are nearer the type than the other plants referred under the genus.

Corda's descriptions and figures of *Sphaerosoma fuscescens*

point to a plant more like *Sph. fragile* or possibly even *Sph. ostiolatum*, viz., a plant with longer paraphyses and bluntly verrucose spores. In this Zobel, Rehm, Magnus, and Schroeter seem to agree.

Tulasne's note and description and Rouppert's decision make *Sphaerosoma fuscescens* a plant with reticulated spores and with the paraphyses slender and hardly swollen at all at the tip, e.g., like *Ruhlandiella berolinensis*.

It is difficult to reconcile these three views and it needs an undoubted type specimen to settle the question as to the identity of *Sph. fuscescens* of Klotzsch. As a type of such definite kind as we undertake to preserve at present can hardly be expected from a worker of his period, and since it is not out of the bounds of probability that Klotzsch may have had more than one species in his collection, it seems best to the writer to rely upon the description and figures which in spite of certain inconsistencies do fairly definitely correspond to a known plant. That plant is, in the mind of the writer, *Sph. Janczewskianum*. The only objections to considering a species which agrees so closely with the description and figures as does *Sph. Janczewskianum*, to be the type, is the statement of Klotzsch that the spores in his plant were verrucose (while his figures represent them distinctly as echinulate) and the statement of Tulasne that a small, dried specimen of *Sph. fuscescens* sent to him by Berkeley and which had been sent to the latter by Klotzsch, had spores which were reticulate-echinate and paler than those of *Sph. ostiolatum*. Reinforcing this, to a certain extent, is the statement of Rouppert (1909, p. 85) that the specimen sent from Berlin agrees with the statement of Tulasne. Rouppert does not state, however, that this specimen is a type or has other reason for being considered authentic except that it is from the type neighborhood. Another matter of some influence may be the fact that no echinulate-spored specimens are, as yet, recorded from Berlin. Carefully considering all these points, however, it seems to the writer that the weight of probability can hardly prevail against the really convincing figures and description of Klotzsch.

The plant of Corda and Zobel seems equally certainly to be the *Sph. fragile* of Hesse rather than the *Sph. fuscescens* of

Klotzsch, as the writer understands it. The figure 3 of 100 of Taf. XI of volume VI of the *Icones* shows at *f* a hollow portion and a stipe-like structure below it. These, as well as the figure of the spores, asci and paraphyses, can hardly have been drawn by Corda from a plant of either the *Sph. Janczewskianum* or the *Ruhlandiella* types. Rouppert does not state his opinion as to Corda's plant. The writer thinks that Rouppert is probably correct in referring *Sph. fragile* Hesse as a synonym under *Sph. ostiolatum*. There is no indication that Corda had an authentic specimen for examination, but even if he had, with the evidence before us of three different plants of similar aspect and all occurring in central Europe, it certainly makes even confusion possible under specimens considered as part of a type, and in the days of Klotzsch and Corda, types, as noted above, were even less carefully segregated than to-day.

The writer, having given his reasons for considering the echinate-spored plants to be typical of the genus *Sphaerosoma*, desires to examine farther into details of structure and development in order that the characteristics of the genus may be made as plain as possible.

Rouppert has described and figured his *Sph. Janczewskianum* and Polish plants referred to *Sph. echinulatum* and Seaver (1905) has dealt in a similar way with his *Sph. echinulatum*. The writer has had the opportunity of examining a portion of no. 1601a of Rehm's *Ascomycetes Etsiccatae* (labeled *Sph. echinulatum*) and a fine series of specimens of *Sph. echinulatum* from Iowa, kindly sent by F. J. Seaver and T. H. Macbride. The results agree, and these three sets of plants so closely correspond in general and in special details of structure that they represent either two (or possibly three) very closely related species of the same genus.

A noticeable feature of the figures of Seaver (*loc. cit.*, fig. B) and of Rouppert (1909, pl. 3, figs. 6 and 7), is the presence of a distinct periderm, *i.e.*, a layer of sterile tissue extending out from and well beyond the broad region of attachment of the ascocarp, as well as the differentiation of a distinct hyphal hypothecium from an outer pseudoparenchymatous periderm proper. Among the specimens of *Sph. echinulatum* sent by Seaver, the

writer was able to find several fairly young ones and one in particular, prepared for the writer by Dr. N. L. Gardner, shows the young hymenium completely surrounded by the periderm except at a very small area at the apex. Seaver (*loc. cit.*, p. 3) describes the development of the hymenium in young plants as beginning with a small brown spot in the center of the upper surface and spreading until it covers all of the exposed surface. It appears, then, that the species with echinate spores do not properly belong to the Helvellineae but are distinctly hemicleistocarpous¹ and therefore members of the Pezizineae. Since the hymenium is always convex and opens out with a comparatively weakly developed periderm, they seem to belong rather with the Pyronemaceae of Schroeter's arrangement (1897) than with any of the other of his families of Pezizineae. The asci in Seaver's plant are operculate and turn blue with iodine, agreeing thus with Rouppert's Polish specimens referred to the same species and differing in the latter character from Rouppert's *Sph. Janczewskianum* (*Sph. fuscescens* in the sense of the writer.)

The verrucose-spored species, viz., *Sph. ostiolatum* Tul. and *Sph. fragile* Hesse, are described as having the hymenium clothing the entire surface except at the very point of attachment. While no early stages are described or figured by the different authors, the adult structures seem to indicate that they belong to the gymnocarpous forms and consequently among the Helvellineae. There is no differentiated hypothecial layer shown in the figures of Tulasne (1851, pl. 19, fig. 15) nor in those of Hesse (1885, pl. 6, fig. 4). Since neither author has given any detailed drawing of a complete vertical section and since there are no specimens available to the writer for investigation (the only figure giving any further information being the somewhat doubtful Corda-Zobel sketch of 1854, XI, 100, fig. 3), no certainty can be obtained; but it seems best for the present to separate them from *Sphaerosoma* (as limited to an echinate-spored genus

¹ The writer is aware of the discussion concerning the nature and value of cleistocarpous and gymnocarpous characters in the separation of the Helvellineae from the Pezizineae, e.g., by Dittrich (*Cohn's Beitr.*, Bd. 8, 1898, p. 17), E. J. Durand (*Ann. Myc.*, vol. 6, 1908, p. 387), and McCubbin (*Bot. Gaz.*, vol. 49, 1910, p. 195); but since his chief object is to emphasize the distinguishing characters of each group of species rather than to discuss affinities he has used Schroeter's arrangement for convenience.

of the Pezizineae) under Zobel's name of *Sphaerozone*. It seems also that the best view, at present, is to consider both *Sph. ostiolatum* Tul. and *Sph. fragile* Hesse as one species which is to be designated ***Sphaerozone ostiolatum*** (Tul.) comb. nov. (*Sphaerosoma ostiolatum* Tul., 1851, p. 184, *Sphaerozone Tulasnei* Zobel, 1854, p. 53).

There remains for discussion the species of *Sphaerosoma* with reticulate spores. This was referred by Rouppert to *Sph. fuscescens*, but the writer has given, above, his reasons for rejecting this view. The data for a discussion of the plants with reticulate spores come from Hennings (1903), Rouppert (1909, especially pp. 84-87 and pl. 3, figs. 5a and 5b), and the examination of the Californian specimens which also have this type of spore. The genus *Ruhlandiella* was founded on a single specimen, of globular shape, attached by a few mycelial strands, and completely covered on its convex outer surface by the hymenium. The interior of the fungus is coarsely pseudoparenchymatous without differentiated hypothecium. The hymenium consists of cylindrical asci containing eight reticulate-verrucose spores in a single row (at maturity) and slender paraphyses which are hardly at all swollen at the apex and extend only slightly beyond the asci. Hennings' opinion was that the genus differed from *Sphaerosoma* by its globular ascocarp and slender, almost uniformly broad paraphyses. Rouppert, after a study of Ruhland's preparation, from which the drawing and description published by Hennings were made, states that the spores are reticulate (instead of reticulate-verrucose). His figures (*loc. cit.*, pl. 3, fig. 5a and 5b; and text fig. 2) agree with similar features of the plants found on the campus of the University of California by Dr. N. L. Gardner, except that the paraphyses in the California plants are much longer than the asci (pl. 15, fig. 3), curved at the apex, and so slightly swollen that it is generally not apparent. The Californian plants will be considered as belonging to a new species closely related to the *Ruhlandiella berlinensis* of Hennings. They are light brown, translucent, and between fleshy and cartilaginous. They vary in general shape from nearly globular to convolute-cerebriform (pl. 15, fig. 1), but below are more or less, sometimes very strongly, umbilicate and provided with a single

short stout stipe or with several stout mycelial strands as attaching organs. They often rest on a thin and evanescent (?) web of slender hyphae. The size varies from 2 to 6 mm. in diameter and about half to three-quarters that in thickness.

Within, they are coarsely pseudoparenchymatous with very slight differentiation of a hypothecial layer. The hymenium covers the entire outer surface, which is convex and more or less lobed. It consists of long cylindrical asci, each containing eight alveolate spores in a single row at maturity, and very slender paraphyses which are decidedly longer than the asci. (Pl. 15, fig. 3.) No trace of an operculum was seen in any of the, perhaps not over mature, asci in our specimens. The mature ascus turns blue with iodine and is 200 to 250 μ in length and 24-28 μ in breadth, while the paraphyses are considerably longer than the asci, very slender, very slightly swollen at the tip as a rule, and septate. The ripest spores are globular, 21-25 μ in diameter (about 18-20 μ without the wing), and rather irregularly alveolate. They have a very light tint of brown at maturity. (Pl. 15, fig. 4.) One peculiarity of this species is that the outer ends of the paraphyses are bent and enclosed in a rather firm jelly which has blotches of light brown pigment in it.

The writer has now described or passed in review all the plants known to be nearly related to, or connected with the consideration of *Sphaerosoma* as treated by various authors. His conclusions may be summarized thus:

1. That the *Sphaerosoma fuscescens* of Klotzsch is probably identical with the *Sph. Janczewskianum* Rouppert, since Klotzsch's figures indicate that the spines on the spores are short

2. That the *Sph. echinulatum* of European authors (Rehm and Rouppert) differs from *Sph. fuscescens*, as thus understood, in the longer spines of the spore and the reaction of the asci towards iodine solutions. Further study may indicate that this should be considered a distinct species.

3. That *Sph. echinulatum* Seaver differs from *Sph. echinulatum* of Europe and *Sph. Janczewskianum* (*Sph. fuscescens*) in having longer and stouter spines on the spore than either species, but the European *Sph. echinulatum* may be only a geographical variety of the Iowa plant.

4. That the structure of the three species which agree so closely and the development of the American *Sph. echinulatum* show plainly that they belong to the Pezizineae rather than to the Helvellineae. (Cf. note at bottom of p. 113.)

5. That the genus *Sphaerosoma* should be restricted to the two (or three?) species just mentioned.

6. That the *Sph. fuscescens* of Corda, Zobel, and Schroeter, is really the *Sph. ostiolatum* Tul., or *Sph. fragile* Hesse if the latter is kept distinct.

7. That *Sph. ostiolatum* Tul. is probably a member of the Helvellineae, consequently to be separated from *Sphaerosoma*, becoming then, *Sphaerozone ostiolatum* (Tul.) Setchell.

8. That the *Sph. fuscescens* of Rouppert is not that of Klotzsch but rather better placed under *Ruhlandiella* Hennings, and probably identical with *R. berlinensis* Henn.

9. That the California plant is a new species of *Ruhlandiella* for which the name *Ruhlandiella hesperia* is proposed and the following diagnosis provided:

***Ruhlandiella hesperia* sp. nov.**

Ascomatibus cartilagineo-carnosis, dilute fuscis, hemisphericis aut late reniformibus, 2-6 mm. diam., inferne brevi stipite aut paucis fasciculis mycelialibus suffultis, externis omnino hymenio vestitis, internis pseudoparenchymaticis; ascis cylindraceo-clavatis, 200-250 μ longit., 24-23 μ diam., iodurato coerulascentibus, paraphysis elongatis, gracilibus, lente aut passim moderate apice tumidulis, ad apices maxime curvatis et in gelinae strato pigmentato conglutinatis multo quam ascis longioribus; sporis sphericis, dilutissime fuscis, irregulariter alveolatis, 21-25 μ diam.

Ad terram sub foliis Eucalyptus in Berkeley, California, ubi legit Dr. N. L. Gardner, February, 1903. (Exemp. orig. no. 126152 in herb. Univ. Californiensis.)

The writer desires to express his thanks to Professor W. G. Farlow for assistance as to literature and specimens, to the California Academy of Sciences for loan of literature, to Dr. F. J. Seaver and Professor T. H. Macbride for opportunities of exam-

ining specimens, to Professor Dr. Paul Magnus for the communication of valuable information, to Dr. N. L. Gardner for preparing a series of specimens, and to Mr. W. C. Twiss for preparing certain drawings.

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1839. *Sphaerosoma fuscescens* Kl. Pl. 467, in Dietrich (A). *Flora Regni Borussici*, Bd. VII.

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1896. *Ascomycetes*, in Rabenh., *Krypt. Flora*, ed. 2; Bd. 1, abth III.

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Zobel, J. B.

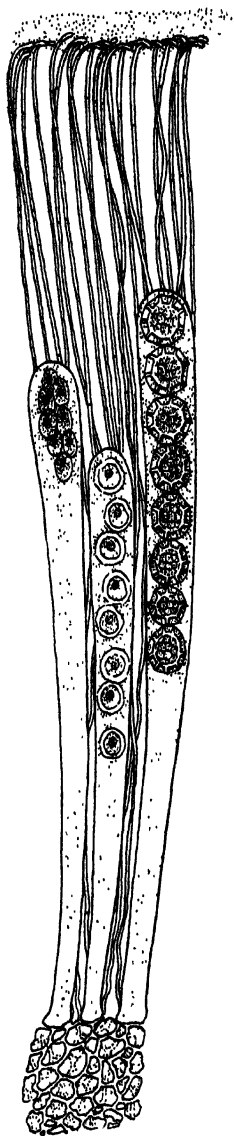
In Corda, *Icones Fungorum*, Bd. VI.

PLATE 15.

Ruhlandiella hesperia Setchell.

1. Habit of mature ascocarp. $\times 20$ diam.
2. Median vertical section of the same. $\times 20$ diam.
3. Portion of hymenium showing asci at different stages of maturity and paraphyses. $\times 320$ diam.
4. Mature spore. $\times 2000$ diam.

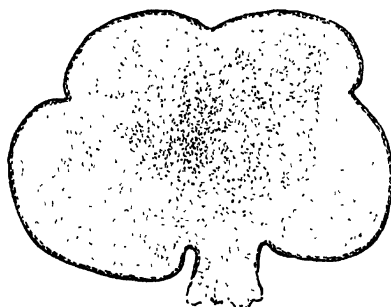
All the figures were drawn under the direction of the writer, figures 1 and 2 by H. N. Bagley and 3 and 4 by W. C. Twiss.



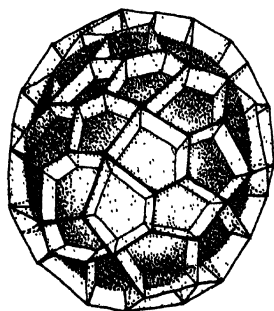
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August 26, 1910

VARIATIONS IN NUCLEAR EXTRUSION
AMONG THE FUCACEAE.

BY
NATHANIEL LYON GARDNER.

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INTRODUCTION.

The group of brown sea-weeds known as the Fucaceae affords an excellent illustration of the manner in which our ideas have changed from time to time in regard to what should constitute the basis of classification of plants.

Linnaeus probably did more than any other person in modern times to stimulate investigation in systematic botany, being a most energetic and careful worker himself in this field of activity; but with Linnaeus the dominant idea concerning systems of grouping was purely artificial and conventional, his whole purpose being to devise systems whereby one could readily place in its proper group a newly discovered organism or easily trace an organism to its name after having once been classified. In other words, his system was wholly utilitarian in its purpose. To this end he would naturally seize upon the gross morphological characters and emphasize them. Groups were established

on the basis of these gross morphological characters, and organisms with widely divergent affinities were thus assembled into these groups without regard to their relationship. The larger spore-bearing plants growing in the sea, particularly the brown and the red algae, were mostly grouped into the genus "Fucus," meaning "sea-weed," without reference to methods of reproduction or natural relationship.

Turner (1808-1819) followed out this system with the algae, adding many more forms to the genus "Fucus." The four volumes of his *Fuci* contain descriptions of about 275 species of "Fucus."

Later systematists conceived the idea of a more rational system of classification combining the idea of utility with the more scientific aspect of the subject, grouping organisms into natural systems which would represent their genetic relationships. This necessitated more careful research into the histological, reproductive, and developmental characters. Such researches have only been made possible by the rapid improvement and perfection of the microscope; and the invention of methods in technique.

Kützinger (1843) was among the first to apply this new system of classification to the algae. The *Fucaceae* were very much more limited in their scope by his treatment as compared to what had been included in them by previous writers. J. G. Agardh (1848) also did a great work on the systematic rearrangement of the algae.

The foundation of our knowledge of the *Fucaceae*, as we understand it to-day, was laid by Decaisne and Thuret, whose first paper on the characters of the antheridia and oogonia of *Cymaduse tuberculata* (Stackh.) Dec'ne. et Thuret, *Pelvetia canaliculata* (L.) Dec'ne. et Thuret, *Ozothalia vulgaris* (L.) Dec'ne. et Thuret, *Fucus serratus* L. and *F. vesiculosus* L., appeared in 1845. This work was soon followed by Thuret's paper which appeared in 1851, in which the conceptacles of *Fucus platycarpus* Thuret and *Halidrys siliquosa* (L.) Lyngb., with their reproductive organs, were described and beautifully and accurately figured.

In 1855 Thuret published another excellent paper in which

he described and amply figured the antheridia and oögonia of *Fucus vesiculosus*. He showed the escaping antherozoids and oöospheres, and the fertilization and germination which follows.

The classical work of Thuret and Bornet appeared in 1878. In this production much of the previous work of Thuret and Decaisne was reviewed and amplified, and some additional genera belonging to the Fucaceae were added. Three species of *Fucus*, viz., *F. serratus* L., *F. vesiculosus* L. and *F. platycarpus* Thuret, *Ascophyllum nodosum* (L.) Le Jolis, *Pelvetia canaliculata* (L.) Dec'ne. et Thuret, *Himanthalia lorea* (L.) Lyngb., *Bifurcaria tuberculata* Stackh. and *Cystoseira fibrosa* (Huds.) Ag. were very elaborately and accurately illustrated and described. All of the species of *Fucus* were shown to develop eight oöospheres in each oögonium; at present this is one of the final characteristics upon which we depend to determine the genus *Fucus*, *Notheia* being the only other known genus which develops eight oöospheres in each oögonium. *Ascophyllum* was shown to develop four, *Pelvetia* two, and each of the other three genera above mentioned one oösphere in each oögonium.

In none of these investigations were the cytological features of the reproductive organs studied. Cytological technique was still in its infancy.

Oltmanns (1889) was the first algologist who undertook seriously to investigate the Fucaceae from histological and cytological standpoints. He studied with considerable detail the nuclear behavior in the development of the oögonium. In his first publication he confirmed the discoveries of Decaisne and Thuret as to the division of the oöospheres in the genera upon which they had worked. His investigations extended much farther in this respect, covering the larger part of the genera then included in the Fucaceae, and with few exceptions settled the question of the number of oöospheres developing in the oögonia. His scheme of classification was based largely upon histological characters. He laid much stress upon the shape of the apical cell in the growing point, and traced this with much detail from the germination of the oöspore until the adult form of the plant was fixed. The other character which he emphasized was that of the number of oöospheres developing in each oögo-

nium. On account of imperfect material or lack of material in his scheme of classification, some doubt, particularly regarding the number of oöospheres, was expressed as to the proper placing of the following genera: *Coccophora*, *Xiphophora*, *Sarcophycus*, *Myriodesma*, *Ecklonia*, *Scaberia* and *Splachnidium*.

Xiphophora has been studied by Barton (1893) who shows that four oöspores instead of one, as thought by Oltmanns, develops in each oögonium, hence its near affinities are probably to be found in Oltmann's *Fuceae* rather than in his *Lori-formes*, near to *Ascomyllum*.

The research of Mitchell and Whitting (1892) has shown that the character of the sporangium in the genus *Splachnidium* are such as to exclude it from the Fucaceae, and a new family has been proposed for its reception, viz., Splachnidiaceae. From five to six hundred spores are developed in a sporangium instead of one, two, four or eight as in the Fucaceae proper. *Coccophora* has been since studied by Smith (1893) and found to develop but one oösphere, as Oltmanns presumed.

Oltmanns's distinctively new contribution to our knowledge of the Fucaceae concerned the development and subsequent fate of the nuclei in the oögonia of certain Fucaceae. He showed that the nuclei in the oögonium of *Ascomyllum nodosum* undergo three divisions, resulting in eight nuclei, before any division takes place. The contents of the oögonium then divide into four equal parts, each part appropriating one nucleus, the other four nuclei being extruded at the corners of the four oöospheres, where they disintegrate. A similar study of *Pelvetia canaliculata* revealed the fact that eight nuclei are formed in the oögonium, that two of them become centers of oöospheres formed by an equal cross-division of the oögonial contents, and that the other six nuclei are extruded at the equator. His investigation of *Himanthalia lorea* revealed the same phenomena regarding the mitoses of the nuclei as are to be found in the two preceding genera, but in this genus only one nucleus becomes functional, the oögonium never dividing. The other seven nuclei are extruded at various places on the periphery of the resulting oösphere, where they are soon disintegrated. Oltmanns's study was intended only to reveal the number, location, and fate of the

nuclei in the oögonia. He apparently made no attempt to study the details of the mitotic processes which he found to take place in the formation of the eight nuclei.

Farmer and Williams (1896) and Strasburger (1897) took up the work where Oltmanns left it, and studied the cytological detail of the three mitoses, which were shown by Oltmanns to take place in the oögonium. Farmer and Williams investigated *Ascophyllum nodosum*, *Fucus vesiculosus* and *F. platycarpus*. They confirmed the results obtained by Oltmanns regarding *Ascophyllum* and studied the details of the three mitoses in *Fucus*. Three species of *Fucus* were investigated by Strasburger, viz., *F. serratus*, *F. vesiculosus* and *F. platycarpus*.

For our present purposes in classification very little stress is laid upon cytological characters.

Since I began the study of the Fucaceae of the Pacific Coast of North America, with the hope of settling some questions of doubtful relationship and thus extend our knowledge of this interesting group of algae, I have discovered some types of nuclear behavior entirely new, which seemed of enough importance to be worthy of special attention.

The explanation of these phenomena forms the subject-matter of this paper. A more general and extended account of the group I hope to prepare in the near future.

MATERIAL AND LOCALITY.

The material used and the locality in which it may be found are as follows:

First—*Fucus evanescens*, forma *typicus* Kjellm. The material used in this study was collected at Land's End, San Francisco, California. It is a species very common on the Pacific Coast of North America.

Second—A *Fucus*-like plant, which for several years has passed under the name of *Fucus Harveyanus* Dec'ne. The plant was originally collected at Monterey, California, and the description was published by Decaisne in 1864. I collected at San Pedro, California, the material of the same species which first led to the cytological investigation resulting in the knowledge contributed in this paper. I have since collected it at Monterey in

the type locality. For reasons which will soon follow this proved not to be a *Fucus*, and since there is no established genus into which it will fit, a new genus is proposed below for its reception, viz., *Hesperophycus*.

Third—A *Pelvetia*-like plant, which has been known as a form of *Pelvetia fastigiata*. This has been observed to occur on rocks quite commonly along the California coast from Bodega Bay south to Monterey, and doubtless has a much wider range. Two quite distinct forms of this species have been collected. They both grow on rocks at high-tide limit, and in some instances even higher up on the rocks, where they are kept moist by the breakers. This also proved not to be a true *Pelvetia*, and the genus *Pelvetiopsis* is proposed for it below.

Fourth—A form of the last mentioned species, which has never been reported heretofore, which I recently collected at Point Cavallo, opposite San Francisco, California, well inside of the Golden Gate, on the Marin County side, and also at Seal Cove, near Half Moon Bay, San Mateo County, California.

Fifth—*Pelvetia fastigiata* Dec'ne. The type locality for this plant is Monterey, California, where it was collected by Coulter in 1831 and by Douglas in 1830-32. The plant is well described and figured by Harvey (1851). It is the *Fucus fastigiatus* of J. Agardh (1841) described from Douglas's material. Harvey says that his description and figures were made from Dr. Coulter's specimens, and that those collected by Douglas and also by Captain Wilkes at San Francisco, which had come under his observation, are much smaller and are "allied to the European *Fucus canaliculatus*." I apprehend that the collection made by Douglas and Wilkes may be the *Pelvetiopsis* previously referred to, but in the absence of material for comparison the matter cannot be settled at present. This plant has been quite commonly observed along the California coast in the upper littoral zone from Bolinas Bay to San Diego, and doubtless has a much wider range. It grows much more luxuriantly in the southern part of the State, where it commonly grows two feet long, than in the region of San Francisco, not being over ten to fourteen inches long in the latter locality.

Sixth—*Cystoseira Osmundacea* (Menz.) Ag. The material

used for this study was collected in April, 1910, at Moss Beach, San Mateo County, California. This species has been collected frequently at different localities on the California coast from Point Trinidad to San Diego. There may be more than one form of it in this locality, but further study will be necessary to determine this.

A brief diagnosis of the new plants herein considered is deemed to be expedient at this point.

Hesperophycus Setchell et Gardner gen. nov.

Frons a disco radicali, elongata, costata, subpinnata, evesiculosa; receptaculis discretis, terminalibus, non aut lente inflatis; cryptostomatibus in lineis duabus in utroque latere costae; oogoniis oosphaeras duas maxime inaequales amplexantibus.

Genus in habitu Fuco valde simile sed in numero oosphaerarum in oogonio differens.

Hesperophycus Harveyanus comb. nov. Setchell et Gardner.

Fucus Harveyanus Dec'ne., in Harvey, Ner. Bor. Am., part I, p. 70, 1851 (nomen nudum); Voyage Venus, t. 4, 1864 (descr. et tab.); Tilden, Am. Algae, no. 339, 1900; non. J. Ag., Spets, Alg., p. 10, 1868 (*Fucus* verus oogoniis in planta Spetsbergensi a J. Agardh det., 8 oosphaeras amplexantibus!).

Pelvetiopsis Gardner gen. nov.

Frons a disco radicali, inferne cylindrica sed mox complanata, ecostata; receptaculis discretis, terminalibus, fere cylindricis, acuminatis; oogoniis duas oosphaeras maxime inaequales amplexantibus; cryptostomatibus sparsis in partibus juvenilibus.

Pelvetiopsis limitata Gardner comb. nov.

Pelvetia festigiata f. *limitata* Setchell, in Collins, Holden & Setchell, Phyc. Bor. Am., no. 1238, 1905.

f. **typica** fronde mediocri, 8-10 cm. longa, angusta; hermaphrodita.

f. **lata** Gardner f. nov. fronde longiore latioreque, 15-18 cm. longa, frequenter plus minusve contorta; hermaphrodita.

TECHNIQUE.

Several kinds of killing and fixing fluids were tried, among which the most satisfactory results were obtained from Fleming's strong chrom-osmo-acetic mixture, the same reduced one-

half with sea-water and Gilson's mercurio-nitric mixture. Fleming's strong proved to be the best to prevent shrinking of the reproductive organs in the conceptacles, particularly so if the material was injected in vacuo with a small air pump according to the method suggested by Osterhout (1904). This fixing fluid has the disadvantage of blackening the contents of the oögonia, especially of the oldest oöospheres, to such an extent that it is difficult to get good results with nuclear stains. The dark color may, however, be removed with hydrogen peroxide, but this has a strong tendency to loosen the sections from the slide, thus seriously interfering with further manipulation. Gilson's mercurio-nitric mixture proved satisfactory in every way, with the exception that it does not harden the material quite sufficiently to prevent slight shrinking when the material is dehydrated. Microtome sections 10-15 μ in thickness were employed.

Since it was desired in this study only to ascertain the number, size, and location of the nuclei in the oögonia, and not to work out the details of the mitotic processes, very little attention has been paid to the different kinds of stains. At the beginning of the work Heidenhain's Iron Haematoxylin was tried and found to fulfill all of the requirements desired. It was found that over-staining and washing out yielded the best results. Mounted sections were placed in a solution of the iron mordant for two hours, but longer time will not injure the material. The superfluous iron was washed out with water and the sections were then placed in an aqueous solution of haematoxylin for five hours, over night however will not injure them. The sections were then placed in the mordant and allowed to remain until the desired results were obtained, after which they were dehydrated and mounted in balsam in the usual way.

RESULTS.

Fucus evanescens forma *typicus*. Sections of *Fucus* treated according to the above methods gave very excellent results. Nothing new was ascertained in connection with the nuclear behavior in this form. The results of previous workers on *Fucus* are here confirmed, three mitoses taking place in the oögonium,

resulting in the formation of eight nuclei, each of which ultimately becomes the center of an oosphere.

If it is desired to stain the escaped oospheres the following method may be used. *Fucus* plants are allowed to remain out of water for six to ten hours and allowed to become partially dry. The receptacles are then plunged into sea-water, after which the oospheres will escape in great abundance in a short time along with copious mucilage. These are now placed on a slide and allowed to dry. The mucilage will cause these oospheres to adhere to the slide sufficiently so that with a little care they can be handled in the same way that microtome sections are, and the nuclei are clearly differentiated.

Hesperophycus Harveyanus. In this genus we have the same history in the formation of the oogonium as we have in *Fucus*. The young oogonium is cut off from a cell in the wall of the conceptacle. In some cases there is a distinct pedicel cell, and in others the oogonia are sessile. The young oogonia increase to considerable size, become much more granular than the pedicel cell, and soon after, the first mitosis of the nucleus takes place. Soon after, the second mitosis takes place, both nuclei dividing simultaneously—at least, I was never able to find any oogonia with three nuclei. The third mitosis, however, does not take place simultaneously in all the four nuclei, for oogonia with five, six, seven, or eight nuclei may be found, but eventually each oogonium produces eight nuclei.

From this stage on the subsequent history departs from the *Fucus* type. One of the nuclei enlarges to several times as great as the other seven, and gravitates to the center of the oosphere, while the other seven smaller nuclei collect at the base and arrange themselves as shown in plate 16, fig. 8. Soon after the eight nuclei are formed and have arranged themselves, a division of the oosphere takes place, resulting in two unequal parts, as shown in plate 16, fig. 9. Both oospheres escape from the oogonium surrounded by the inner gelatinous walls, which very soon dissolve after coming in contact with the sea-water, acting very much the same as *Pelvetia* in this respect (plate 16, fig. 10). The subsequent fate of the small oosphere has not been ascertained, but it is presumed that it is never fertilized. It is much

more transparent and less granular than the large oosphere, and seems depauperated in every way. It may persist for several days, but no signs of germination have ever been observed.

Pelvetiopsis limitata and *Pelvetiopsis limitata* forma *lata*. These two forms have the same obvious characters in regard to the formation of the oogonia and oospheres, and, moreover, possess the same history as that of *Hesperophycus* in the formation of these organs. It is rather an interesting coincidence that this type of oosphere formation should occur in two plants so unlike in vegetative characters. *Hesperophycus* is so much like a *Fucus* in vegetative characters that apparently no one has ever questioned the generic position of the plant, although considerable doubt has been expressed from time to time by different writers as to its specific relationship. The same may be said in part of *Pelvetiopsis*. Its vegetative characters are such as to lead one to include it in the genus *Pelvetia*, and its habitat, high up on the rocks, would lead one to suppose it to be only a stranded form of our *Pelvetia fastigiata* which grows lower down. The oogonia of the type of the genus are illustrated in plate 16, figs. 1-7, and the escaped oospheres of forma *lata* are illustrated in plate 17, fig. 17.

Pelvetia fastigiata. The genus *Pelvetia* was founded by Decaisne and Thuret (1845), having for one of its chief characteristics the cross-division of the oosphere into two equal parts. *Pelvetia canaliculata*, described and figured in the above mentioned paper, is the *Fucus canaliculatus* of Linnaeus. The genus was separated from the *Fucus* chiefly because of the development of only two oospheres in the oogonium instead of eight, as in the genus *Fucus*. The division of the oosphere in *P. canaliculata* is perpendicular to the longer diameter of the oogonium. In *P. fastigiata* the division is perpendicular to the shorter diameter as shown by Harvey (1851). Yendo (1907) states that the division in *P. Wrightii*, forma *typica* and forma *japonica*, is likewise perpendicular to the shorter diameter, and occasionally the division is oblique. I find that this oblique division also takes place occasionally in *P. fastigiata* (plate 17, fig. 13). Another rather rare condition is illustrated in plate 17, fig. 16, in which the oosphere of *P. fastigiata* divides into three equal parts.

The distinctly new feature brought out in this study of *P. fastigiata* is that the six extra nuclei are cast out in the center between the two oöospheres instead of on the surface, as in *P. canaliculata*. They are very small and thus may be easily overlooked (plate 17, fig. 15). They soon disintegrate after being extruded.

Cystoseira Osmundacea (Menz.) Ag. A very brief study of the nuclei in the oögonium of this species revealed the fact that only one oöspore containing one large nucleus develops in each oögonium, and that seven small nuclei, formed in the original oösphere, are cast out, often in pairs, at any point on the periphery of the oösphere, before it escapes from the oögonium (plate 17, fig. 18). I have not yet traced the development of the oögonium and the successive mitoses resulting in the eight nuclei in this form.

In conclusion I wish to express my appreciation to Professor W. A. Setchell, under whom the work has been carried on, for many helpful suggestions.

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EXPLANATION OF PLATES.

EXPLANATION OF PLATE 16.

Figs. 1-7.—*Pelvetiopsis limitata* (Setchell) Gardner.

1. Young oögonium containing but one nucleus.
2. Oögonium after the first mitosis.
3. Oögonium after the second mitosis.
4. Oögonium containing seven nuclei.
5. Mature oögonium containing a large nucleus in the upper end and seven small nuclei in the lower end.
6. Oögonium with the contents divided into two unequal parts, the upper larger part containing a large nucleus centrally located, and a lower smaller part containing seven small nuclei.
7. A representation of a mature oögonium of average shape and size before division.

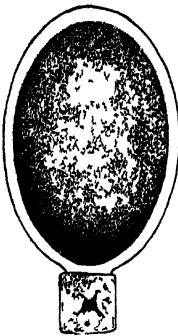
Figs. 8-10.—*Hesperophycus Harveyanus* (Dec'ne.) Setchell and Gardner.

8. Sessile oögonium with the oösphere divided into two unequal parts, an upper larger part containing the large nucleus centrally located, and a lower smaller part containing seven small nuclei.
9. A later stage of figure 8 with a short pedicel cell, and with the small oösphere nearly spherical.
10. A still later stage, showing the escaped oöospheres after the gelatinous walls have dissolved away.

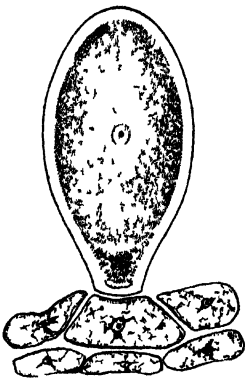
Figs. 1-6 were drawn from prepared material, and figs. 7-10 from fresh material. All were drawn with the aid of a camera-lucida, $\frac{1}{6}$ obj., no. 4 comp. oc. All reduced four times.



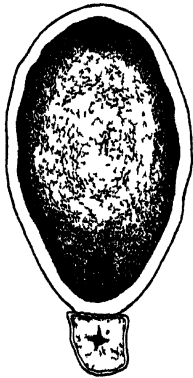
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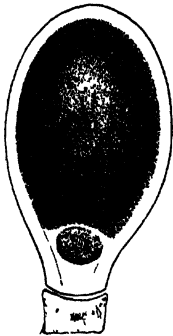
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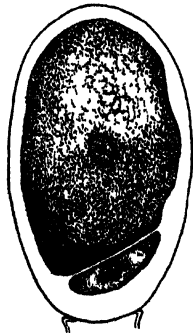
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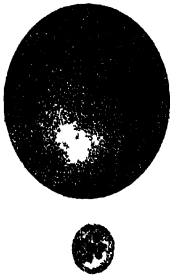
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EXPLANATION OF PLATE 17.

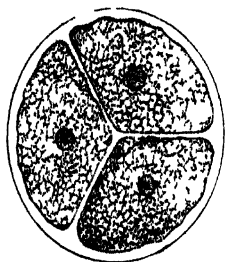
Figs. 11-16.—*Pelvetia fastigiata* Dec'ne.

11. Mature oögonium before division.
12. The two oöospheres after having escaped from the oögonium and the gelatinous walls dissolved away.
13. Oögonium on a long pedicel, showing an oblique division of the contents into two equal parts.
14. The same as fig. 13, with longitudinal division of the contents.
15. Median section through an oögonium showing two large nuclei in the oöospheres, and four small nuclei between them, the other two nuclei were either above or below this plane.
16. Median cross-section through an oögonium containing three equal oöospheres.

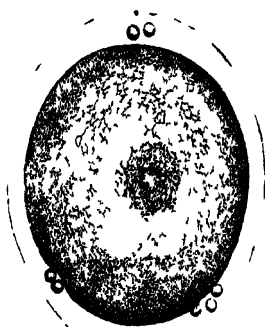
Fig. 17.—*Pelvetiopsis limitata* f. *lata*. Gardner. Two unequal oöospheres soon after escaping from the oögonium.

Fig. 18.—*Cystoseira Osmundacea* (Menz.) Ag. Oögonium containing a large oöosphere with seven small nuclei on the periphery.

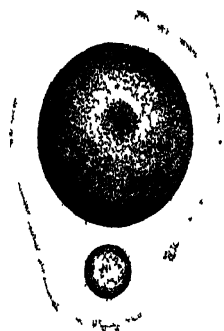
Nos. 11, 12, 13, 14, and 18 were drawn from fresh material, and 15, 16, and 17 were drawn from prepared material. All were drawn with the aid of a camera-lucida, $\frac{1}{6}$ obj. and no. 4 comp. oc. All were reduced four times.



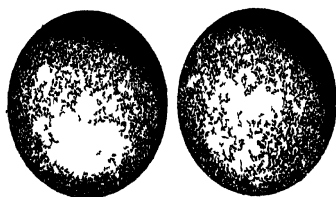
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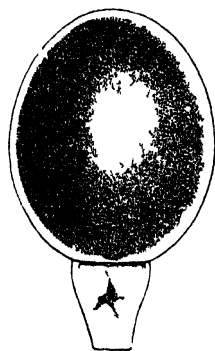
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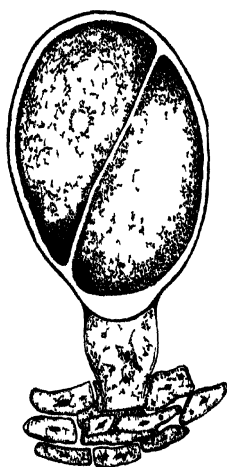
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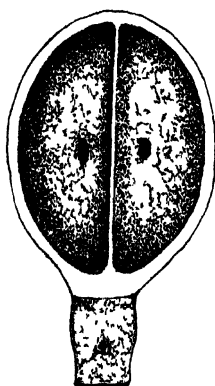
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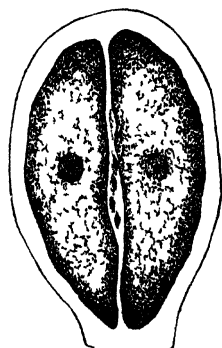
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15

THE NATURE OF THE CARPOSTOMES IN
THE CYSTOCARP OF AHNFELDTIA
GIGARTINOIDES*

BY

ADA SARA McFADDEN.

At Lands End, a rocky beach in the neighborhood of San Francisco, many seaweeds grow, among which is found in abundance a red seaweed which has usually passed under the name of *Ahnfeldtia gigartinoides*. My attention was directed to this plant by Dr. W. A. Setchell of the University of California. This red alga is found growing in compact, wiry masses, two-thirds of the way down the littoral zone, on rocks exposed usually to a heavy surf.

The plants all grow from a common base. They are cartilaginous in texture, reddish purple in color, and the branching is three to five times dichotomous, as well as one-sidedly proliferous. The proliferations are given off at a wide angle. The plants attain a height of nine inches.

In a cross-section the frond is seen to be composed of two kinds of cells. The central part consists of thick-walled, large cells. Surrounding these cells are slender, densely packed cells in anticlinal rows. The latter cells are longer toward the center and shorter toward the margin. Outside the anticline is the cuticular layer, which is a tough, excreted membrane.

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The only fruiting bodies thus far found are the **cystocarps** which are the same color as the rest of the plant. They are fusiform in shape and located in the center of the frond. They are situated toward the tips of the fronds or on the proliferations on the sides of the fronds. A few multiple **cystocarps** were found which were in the axils.

The main part of the cystocarp consists of two kinds of cells. In the central part are large, irregular, thick-walled cells. Between these and the surface are slender, densely packed cells in anticlinal rows, as in the frond. The same tough membrane which surrounds the frond also surrounds the cystocarp. The contents are joined by projections. From the large, irregular cells of the center, the reddish, spheroidal spores are found in threads. Only a few central cells, which are large and oblong, were seen, never more than one central cell in a cystocarp.

Extending from the surface of the cystocarp through the anticline are long, narrow, irregular slits which are the carpostomes. (See plate 18, fig. 1.) The carpostomes are filled with several-celled filaments which are projections of the cells of the anticlinal rows bordering the carpostomes (see plate 18, figs. 1 and 2). The origin of the carpostomes is doubtful, but there seem to be indications that these slits are formed by decomposition, because of the presence of decomposed matter in the slits. By multiplying the number of carpostomes found in cross-section by the number found in longitudinal section, in the case of several cystocarps, I computed the average number in a cystocarp to be about forty-two. The carpostomes are not limited to any definite region. Sometimes a longitudinal section shows them along at the center, and sometimes only toward the apex or the base, and again they are found both in the center and toward both ends. The long diameter of the carpostome is parallel with the long diameter of the cystocarp, for in a cross-section the cystocarps are narrow and in longitudinal section they are elongated.

There is a question as to the name of the California plant, whether it is *Ahnfeldtia gigartinoides*, or *Ahnfeldtia concinna*. It has usually passed under the name of *Ahnfeldtia gigartinoides*,

which was described from a specimen on the Mexican coast in 1847 by J. G. Agardh in his paper, "Nya Alger fran Mexico," p. 12. In 1849, Kützing published in his *Species Algarum*, p. 789, a description of this plant under the name of *Gymnogongrus gigartinoides*. In 1851 J. G. Agardh published (*Species Genera et Ordines Algarum*, vol. II, part 1, p. 311), a more complete description of *Ahnfeldtia gigartinoides*. *Ahnfeldtia concinna* was described from Hawaiian specimens. It was first mentioned in 1822 by C. A. Agardh in his *Species Algarum*, p. 312, under the name of *Sphaerococcus concinnus* B. *Immersus*. In 1851 J. Agardh (*Species Genera et Ordines Algarum*, vol. II, part 1, p. 312) called it *Ahnfeldtia concinna*.

The description of *Ahnfeldtia gigartinoides*, as given by J. Agardh, describes the Lands End plant with the exception of the length. He gives the length as about two inches, but the Lands End plant attains a length of nine inches. The Lands End plant differs in three ways from the description of *Ahnfeldtia concinna* as given by J. Agardh: (1) As to place where it grows. *Ahnfeldtia concinna* grows in Hawaii. The species I studied grows along the coast of California. (2) The color of *Ahnfeldtia concinna* is purplish, the color of the *Ahnfeldtia* from Lands End is a reddish purple. (3) The cystocarps of *Ahnfeldtia concinna* as described by J. Agardh project from the frond more or less hemispherically. The cystocarps in the plant from Lands End were fusiform in shape and in the center of the frond.

To get a further comparison between the Lands End plant and *Ahnfeldtia concinna*, a study was made of plants of the latter species from the Hawaiian Islands collected by Miss Minnie Reed. Two additional differences were found: (1) The Hawaiian *Ahnfeldtia* when put in water becomes gelatinous; the *Ahnfeldtia* from Lands End remains cartilaginous. (2) The structure of the cystocarp was not the same. The cell walls of the Hawaiian *Ahnfeldtia* were more transparent and the cells of the antilene narrower in cross-section. Only in one cross-section did I find carpostomes and none were found in longitudinal section, which shows that they are not so numerous in

the *Ahnfeldtia concinna* as in the plant from Lands End. The large central cells are very numerous in the Hawaiian plant. In one cross-section eleven were counted. They are between the cells of the anticline and the cells of the center. In the cross-section which contained eleven central cells, part of a trichogyne was found. It could be traced from the egg cell half way to the surface of the cystocarp. It was a slender transparent tube.

From such a study of the *Ahnfeldtia* obtained at Lands End and *Ahnfeldtia concinna*, I have found that *Ahnfeldtia gigartinoidea* and *A. concinna* are different species and that the plant found at Lands End is *Ahnfeldtia gigartinoidea*, as described by J. G. Agardh.

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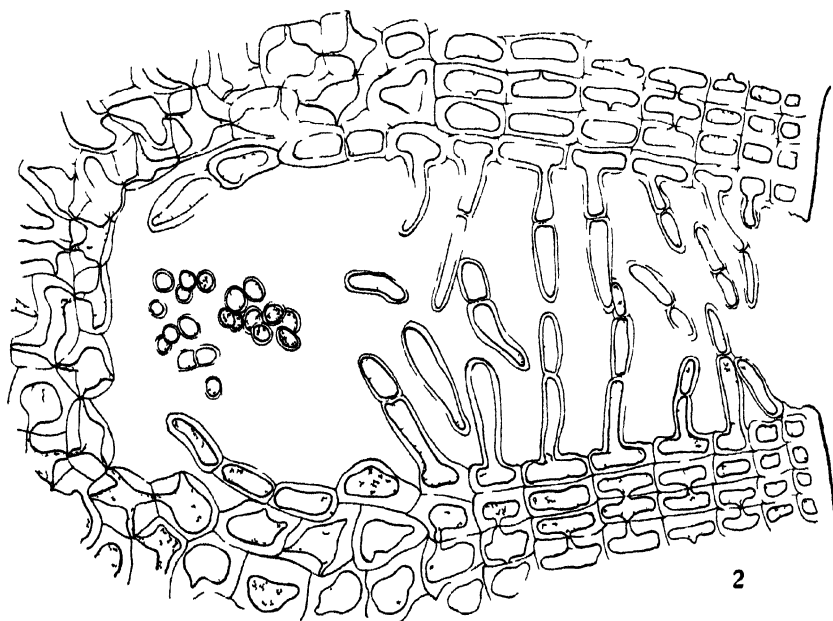
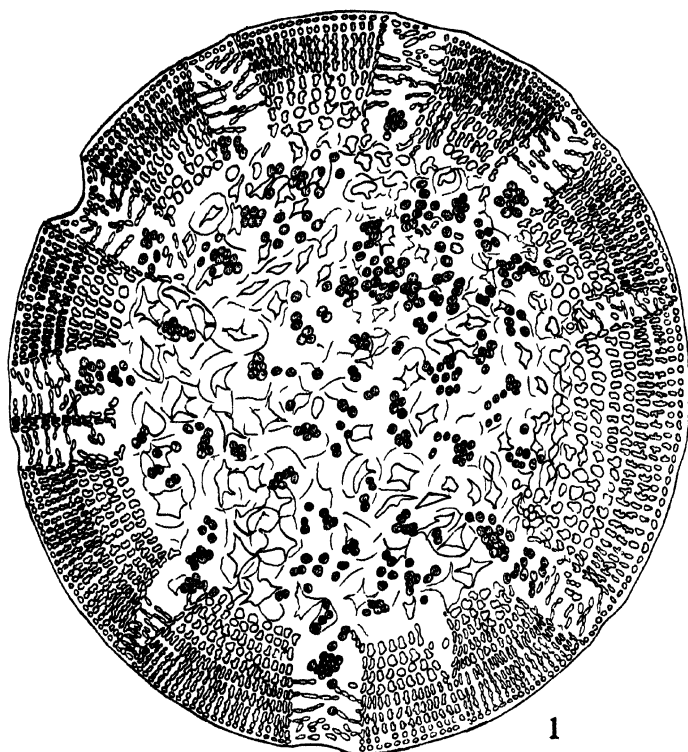
EXPLANATION OF PLATE 18.

Ahnfeldtia gigartinoides J. Ag.

1. Cross-section through a cystocarp showing clusters of spores and several carpostomes.

2. Cross-section of a carpostome.

Drawn by Ada S. McFadden from the prepared specimens. Somewhat diagrammatic.



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ON A COLACODASYA FROM SOUTHERN
CALIFORNIA*

BY

MABEL EFFIE McFADDEN.

Attention was first called to the matter of parasitic Florideae by Reinsch in 1874 (*Contrib. ad Algol. et Fungol.*). Here the first descriptions of several forms are given. In addition, several structures were described as parasites which, on further study, have proved to be quite different. Among these structures are warts and holdfasts, now recognized as essential parts of the plant on which they occur. Interest was aroused by this beginning and the work has been gradually extended.

The work on the parasitic Florideae of California was begun by C. P. Nott. In 1897, he published (*Erythea*, vol. V, p. 81-84) notes on "Some Parasitic Florideae of the California Coast." He enumerates three species, *Sterrocolax decipiens* Schmitz, on *Ahnfeldtia plicata* (Hudson) Fries, *Gonimophyllum Buffhami* Batters on *Nitophyllum Ruprechtianum* J. Ag., and *Janczewskia verrucaeformis* Solms on *Laurencia pinnatifidia* Lam'x and on *Agardhiella tenera* (J. Ag.) Schmitz (*Rhabdonia Coulteri* Harv.). In 1896 Professor A. J. McClatchie found a species of *Harveyella*, *H. mirabilis* Schmitz (now *Gracilariophila oryzoides* Setchell and Wilson, *Univ. Calif. Publ. Botany*, vol. 4, p. 81, 1910) growing on *Gracilaria multipartita* (Clem) Harv., and

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also a species of *Actinococcus* on *Gymnogongrus linearis* (Turn.) J. Ag.

In 1905, Professor W. A. Setchell published (*Nuova Notarisia*, April, 1905) notes on "Parasitic Florideae of California." In addition to the species already mentioned, he adds *Ceramium codicola* J. Ag. on *Codium mucronatum* var. *californicum*, *Ricardia Montagnei* var. *gigantea* Farlow on *Laurencia virgata* J. Ag. and *Peyssonneliopsis epiphytica* Setchell and Lawson on a species of *Callymenia*.

Mention is also made (*loc. cit.*) of a few specimens of a parasitic red alga, growing on *Mychodea episcopalis* J. Ag. "This parasite was first detected by Professor W. G. Farlow, who thinks that it represents the type of a new genus, but further supplies of material are awaited." Later a large amount of material was found at San Pedro, California, by Dr. N. L. Gardner, in exactly the same locality and on the same host, and the material was given to me for study.

The host, *Mychodea episcopalis* J. Ag., was first described by J. G. Agardh (1884, p. 82) and later by De Toni (1897, p. 282). Specimens were distributed in Phyc. Bor. Amer. No. 1497, having been collected by Miss S. P. Monks at San Pedro, California, in 1907. Its identity is indicated by the following note: "This seems to agree with the type specimens in Herb. J. Ag." (*loc. cit.*).

The *Mychodea* has a simple, branched frond. The branches are lateral, and are characterized by being suddenly attenuated at the base, where they are attached to the main frond. The tip of the main frond is often conspicuously coiled, and the tips of the lateral branches are also sometimes coiled. The frond is made up of a central axis, surrounded by two to four layers of cells, forming the cortex. Adventitious holdfasts are developed at intervals along the fronds. No fruiting bodies have yet been found.

The parasite appears as little nodules along the thread of the *Mychodea*. These have very little pigment, so appear as white dots, about 0.5-1.5 mm. in diameter, on the surface of the *Mychodea*. The host is often slightly bent at the point where the

parasite appears, showing that there is a disturbance in the growth of the host at that point.

A more careful study of this relationship shows that the parasite, which probably enters from the outside and breaks through between the cells of the host, immediately grows inward between the cells of the cortex of the host to the central axis. This penetration is brought about by multicellular rhizoidal branches, which force themselves in between the cells of the host. After this first simple penetration, which does not greatly affect the arrangement of the cells of the host, these rhizoidal branches spread out, forming a compact central body, within the host. This gradually enlarges and sends out branches down along the central canal. The growth of this central mass of the parasite, forming, as it does, a wedge among the cells of the host, forces them farther and farther apart (see plate 19, fig. 1). Often the rhizoidal branches of the parasite completely encircle the central axis, pushing out in both directions from the starting point.

While this is going on, a wart of similar cells has developed at the surface (see plate 19, fig. 1). This is often a much larger mass of tissue than that which forms within the *Mychodea* filament. In both cases this tissue is composed of large, irregular-shaped cells, with rather thin walls. The contents of the cells in the specimens examined were shrunken, due to the action of the formalin solution in which they were placed. But, in spite of this shrinkage, a difference could be noted, in almost every case, between the cells of the parasite and the cells of the host. The cell contents of the former take the stains used in a slightly different way and appear more granular. The cell-walls of the parasite are almost transparent, having stained very slightly, while the walls of the host stain quite deeply.

From the wart of tissue growing outside of the *Mychodea* filament, branches arise which bear the organs of fructification. The wart forms the central half of the tuft, and the branches radiating from it form the other half. All three kinds of organs, antheridia, cystocarps, and tetrasporangia, are found, and each is borne on a different plant, that is, all the branches arising from a given wart bear the same kind of reproductive organs.

The structure of the branches of the parasite is of the Polysiphonial type. There is a large central axis with a single circle of seven or eight pericentral cells about it (see plate 19, fig. 3). There are two transverse partitions formed in each pericentral cell, so that there are three cells formed from each. It was quite difficult to determine the method of branching. But after careful study of the growing tips of the branches, I was able to find some instances (see plate 19, fig. 2) which correspond almost exactly with the figures by Falkenberg (1901, plate 8. fig. 18) and so determine that the branching is sympodial.

In addition to the large branches bearing the reproductive organs, there are other smaller branches growing from the wart. These are quite simple in structure, being one cell wide at the tip, but often two or three cells broad at the base, and measuring about $61\ \mu$ in length and $22\ \mu$ in breadth.

These branches may possibly be hairs, or they may be aborted branches. They are evidently different in structure from the larger fertile branches, but their exact nature is still doubtful.

The stichidia are borne laterally on branches arising from the wart. They are lance-shaped with a peculiar curved, or hooked tip. This curved portion is several cells in length, but only one cell broad (see plate 19, fig. 4). The tetraspores are borne in the middle or basal portions of the stichidium. The tetraspores are quite large and tripartite. Falkenberg (*loc. cit.*, p. 659) makes the following statement concerning the stichidia of *Colacodasya inconspicua*: "Gewöhnlich geht demgemäss das fertile Sympodium in zwei auseinanderspreizende Stichidien aus." I find that the stichidia in our plant are not always branched, and when branching occurs, it may be double or occasionally triple. Each of these branches show the characteristic curved tip.

The antheridia are borne on similar branches, but on different plants, as has already been stated. The antheridial branch is smaller than a stichidium, more cylindrical and blunt at the apex. The antherozoids are minute and crowded closely together at the surface of the antheridium, having the typical Polysiphonial form (Reinsch, 1890. Taf. XIII, figs. 2 and 3).

The cystocarps are born laterally on branches from the wart.

The fully developed cystocarp is an urceolate body, with a distinct carpostome at the top. The wall of the cystocarp is made up of a layer of small cells. From the base of the interior of the cystocarp, numerous ooblastema filaments arise, at the end of which the spores are formed. Falkenberg states that these filaments have monopodial branching (Falkenberg, 1901, p. 659). I have been unable to verify this satisfactorily, but such evidence as I have tends towards the same opinion. The spores are pear-shaped, numerous, $16\ \mu$ long, and borne singly, i.e., this is a typical Rhodomelaceous cystocarp.

The procarp arises from a small lateral branch near the tip of the frond; on this branch is borne a large auxillary cell, with several other cells associated with it. A more careful study of the younger stages would probably show a trichogyne, but I have not yet found one. The ooblastema filaments are developed with the spores at their tips, and around this the pericarp is formed. The pericarp arises as is normal for the family of the Rhodomelaceae and consists of a single layer of small cells. A broad carpostome is situated at the apex of the pericarp.

From the fact that the cystocarp is of the typical Rhodomelaceous type, this parasite is to be placed in the family of the Rhodomelaceae. From the fact that the branching is sympodial and not monopodial, we know that the parasite belongs to the sub-family Dasyeae. Of this sub-family, only one genus, *Colacodasya*, is described as parasitic. We, therefore, turn our attention to this genus.

The type species, *Colacodasya inconspicua*, was described and figured by Reinsch (1890, pp. 369-372; Taf. XII, Figs. 1-7; Taf. XIII, Figs. 1-5) under the name of *Merania inconspicua* parasitic on *Merania microcladioides* and on *Polysiphonia anisogona* and found in the South Georgian Sea. Schmitz, after examination of the original material, created for this species a new genus, calling it *Colacodasya inconspicua*. Falkenberg also examined the original preparation and verified the description given by Reinsch and added figures (1901, pp. 658-660; Taf. XVIII, Figs. 18 and 19). From these descriptions my knowledge of the type-species was obtained.

The specimens which I have examined agree with the descriptions in the following ways: (1) The plant is a small parasite. (2) All three kinds of fruiting bodies were found, each growing on a separate plant. (3) The structure of the cystocarp corresponds to the description. (4) The number of pericentral cells is about the same.

But the specimens which I have studied differ from the descriptions in several ways. (1) In the matter of geographical location, the type-species was found in the South Georgian Sea, while the material which I studied was found at San Pedro, California. (2) The host plant, instead of being either of those mentioned by Reinsch, is *Mychodea episcopalis* J. Ag. (3) From the drawing given by Reinsch (1890, Taf. XII, 5) one might conclude that the cells of the parasite were very much smaller, and able to penetrate between the cell-walls of the host without causing much disturbance of cell arrangement. In the specimens which I have examined, the case is quite different, as has already been stated. The cells of the parasite are as large as, if not larger than, the cells of the host, and the penetration of these large cells causes a marked disturbance in the cell arrangement of the host. (4) Reinsch describes the stichidia as lance-shaped, but does not mention anything about a curved tip such as is so characteristic of the species which I have studied. (5) The type-species is described as "colore obscure purpureo" (*loc. cit.*, p. 370), while this species is without color, showing very decidedly white against the red color of the host. (6) Reinsch gives the size of the branches or fronds as 54-70 μ broad, and 578-800 μ long. I find in these specimens the fronds are 83-132 μ broad and 182-365 μ long, showing that they are shorter and broader than the type-species.

From a consideration of all these differences, it must be concluded that the parasite found by Dr. Gardner at San Pedro, California, is a new species of *Colacodasya*.

Colacodasya verrucaeformis W. A. Setchell et M. E. McFadden
sp. nov.

Sordide alba, verrucaeformis, 0.5-1.5 mm. diam., parte centrali solida in corpore *Mychodeae episcopalis* J. Ag. usque ad filamenta centralia per rhizoidibus penetrante; ramis liberis 182-365 μ longis et 82-132 μ latis, sympodialiter ramelliferis; cellulis pericentralibus 7-8, transversaliter 2-3—plo divisis; stichidiis lateralibus, simplicibus aut 2-3—plo ramosis, apicibus conspicue uncinatis; antheridiis lateralibus, cylindraceis, rectis; cystocarpis lateralibus urceolatis.

Planta parasitica in *Mychodea episcopali* J. Ag., ad San Pedro crescens in ditione Californiae ubi detexit Dr. N. L. Gardner.

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EXPLANATION OF PLATE 19.

Colacodasya verrucaeformis Setchell and McFadden.

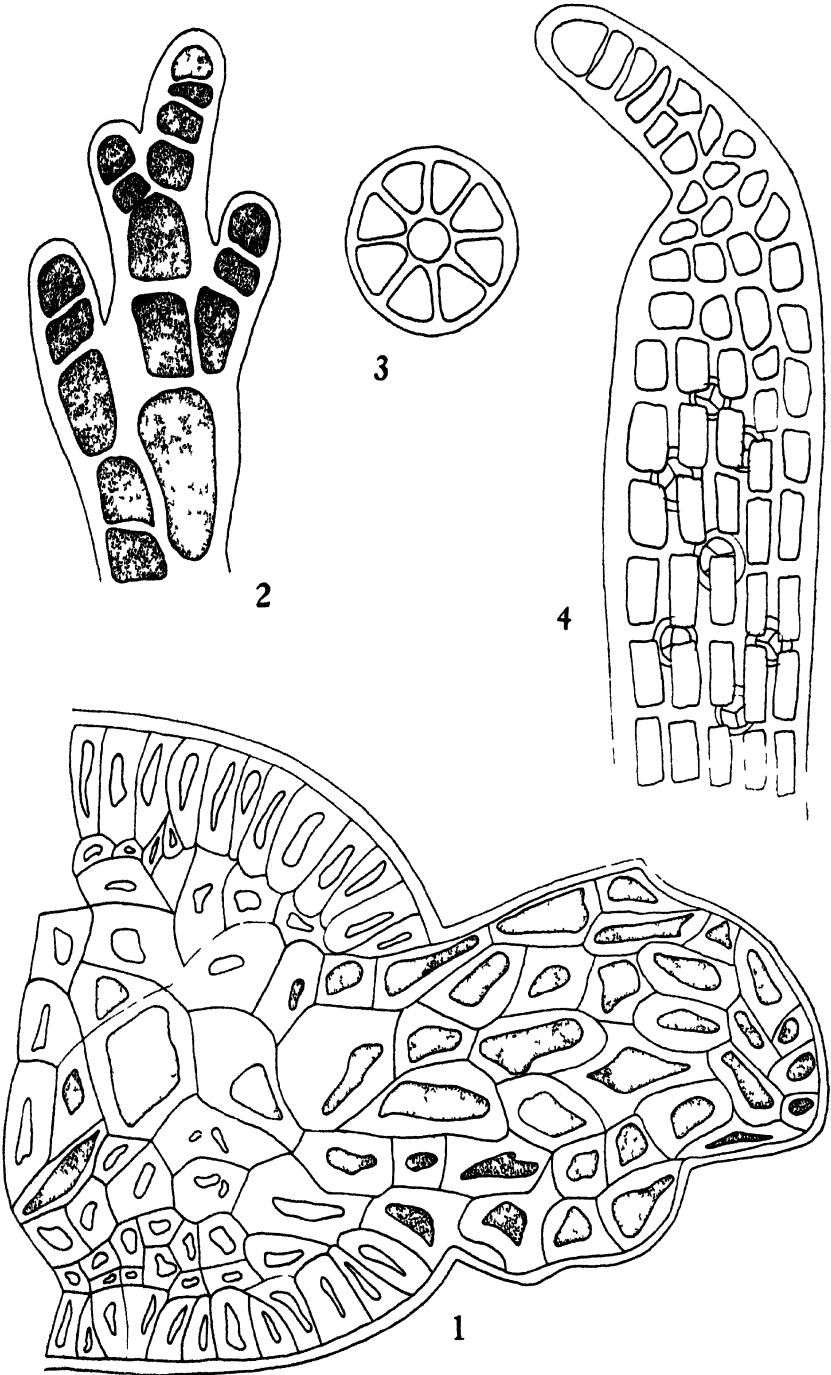
Fig. 1.—Cross-section through the solid portion of the parasite and its host. The shaded portions are the shrunken cell contents of the parasite.

Fig. 2.—Tip of the stem to show the sympodial branching.

Fig. 3.—Cross-section through one of the main branches.

Fig. 4.—Stichidium, seen from the side.

All the drawings were made from the prepared specimens by the writer.



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FRUCTIFICATION OF MACROCYSTIS

BY

EDNA JUANITA HOFFMAN.

Macrocyctis has a very wide distribution along the western coast of North America. Specimens have been found as far north as Sitka, Alaska, and as far south as Lower California. Setchell and Gardner (1903, p. 270) say, "The long Bladder Kelp is not uncommon on the western coast of North America from somewhere in the neighborhood of Magdalena Bay in Lower California up to the strait of Juan de Fuca. It does not seem to be plentiful in Puget Sound itself, or to the north, and it is doubtful whether it grows beyond Sitka, Alaska. It may have floated into Unalaska, but it seems certain that it does not grow there, at least on the side of the Bering Sea. The species is found floating to the south of Unalaska in the open ocean."

Saunders (1901, p. 431) says that *Macrocyctis pyrifera* is not known beyond Sitka, Alaska.

I had the opportunity to examine the dried specimens of Macrocyctis which were collected from the western coast of North America, preserved in the Herbarium of the University of California, and can verify the statements made by Setchell and Gardner (1903, p. 270) and by Saunders (1901, p. 431) regarding the distribution of Macrocyctis along this coast.

While there is much variation in Macrocyctis, the different varieties have been considered as all belonging to the same species and they are usually known under the name of *Macrocyctis pyrifera*.

Hooker (1845, p. 156) says that the specimens of *Macrocystis* occur along the west coast of South America from Cape Horn to the Equator and far westward in the Pacific amongst the Coral Islands. *Macrocystis* also occurs on the Australian coasts, off New Zealand, St. Paul Islands, the Crozet Islands, and is circumpolar generally in the southern hemisphere.

Professor W. A. Setchell called my attention to the manner of fructification in the few specimens in the Herbarium of the University of California which were in fruiting condition, and my principal study has been upon this problem.

The sori appear on the leaves as darker, thickened patches of irregular shape, varying from one-half to an inch and a half in width and from one-half to three or four inches in length, so far as the specimens examined were concerned.

The appearance of the sorus in cross-section shows the unicellular paraphyses and unilocular zoosporangia characteristic of the Laminariaceae closely pressed together, alternately arranged and covered at the top by a layer of firm colorless jelly.

Earlier writers evidently did not find anything which they recognized as fructification, for Turner (1809, p. 104) says "Fructification at present undiscovered."

C. A. Agardh (1821, p. 46) makes the following statement: "Fructus foliis intumescens immersus, constans e tuberculis ubique sparsis, extrinsecus poro minutissimo pertusis & intus includentibus glomerulos seminum numerosissimorum." This description of fruit was undoubtedly taken from a plant no longer included in the genus *Macrocystis*, viz., the Australian plant now known as *Phyllospora comosa*. Consequently this reference has no bearing on our present problem except to note that this first description of fructification applies to another genus.

The first reference to the fructification of *Macrocystis* as now understood was made by Mertens in 1829. Mertens (1829, p. 44) makes the following statement, "in einer kammförmigen Verdickung der Blattsubstanz unmittelbar oberhalb der Blase, welche Verdickung sich durch ihre dunkle Farbe auszeichnet."

In 1831 (p. 172) Dr. Rudolphi also made mention of the fruit of *Macrocystis* in comparison with that of *Ecklonia*.

Our first real knowledge of the fruit dates from 1839 when C. A. Agardh published his paper, "Revision der Algengattung *Macrocyttis*" (1839, p. 294), in which he says: "Man bemerkt auf den Wurzelblättern oder untersten Stammblättern grosser, dunkler gefärbte, unregelmässig begrenzte Flecken besondere auf der oberen Hälfte der Blattscheibe. Wenn der Inhalt dieser Flecken unter das Mikroskop gebracht wird, so wird man in Wassertropfen zwei verschiedene Körperchen gewahr, welche ich um sie besser zu bezeichnen gleich Sporidien und Perisporidien nennen will."

In Postels and Ruprecht (1840, p. 9) this statement appeared, "Fructificatio: Fila in centro stipitis obscura," but this idea is, of course, erroneous.

Various other references to the fruit of *Macrocyttis* have been made by different authors, such as: "The fructification appears to be produced only on the newly formed submerged leaves." (Hooker: 1845, p. 156.) "Sporangienstände auf den grundständigen Blattkörpern." (Kjellman: 1893, p. 260.) "The fructification is found only on root leaves which never rise to the surface and are destitute of air vessels." (cf. Harvey: 1851, p. 84.)

For reference to fruit found on our own coast we turn to Saunders (1901, pl. LX), who gives a picture which shows the sori of *Macrocyttis*.

Setchell and Gardner (1903, p. 270) say: "The sori are supposed to appear only on the bladderless radical leaves, but on specimens from Peru we have seen sori on leaves near the tip and provided with bladders."

While different authors have given the anatomy and histology of *Macrocyttis* more or less detailed study, the Misses Smith and Whitting (1895, p. 84) published the first paper which has direct bearing on the present problem.

They give the following conclusions as the results of their investigations: (1) That the sori appear only on the newly formed bladderless leaves on the stem just above the holdfast, and (2) that the paraphyses and the zoosporangia appear only in the furrows of the leaf surface.

My principal study was upon specimens gathered at Moss Beach, San Mateo County, California, by Professor Setchell on November 29, 1909, February 20, and April 3, 1910. The material of the last two gatherings was brought to me in fresh condition and was then preserved in a formalin solution. The specimens were found in shallow water, very nearly uncovered at the lowest tide, and while this plant seems to be somewhat different from those growing out in twenty to twenty-five meters of water there does not seem to be any good reason for considering it of a different species.

The Moss Beach plants were attached by a short holdfast, which consisted of a flattened rhizome-like structure bearing numerous hapteres, and from which arose several longer or shorter stems bearing leaves of various sizes and shapes. Some of these stems were as much as eight to ten meters long.

Examination showed that sori were present only on leaves near the base. These basal leaves differed from the upper leaves in one or both of two ways:

- (1) Absence of bladders,—or
- (2) Possession of a branching blade.

I have represented in plate 20, fig. 1, sori on leaves with and without bladders. In some of the leaves, division is unequal and unilateral and still in the very young stage like that of the terminal leaf from which the longer frond arises, and in the third leaf which bears a bladder at the base advanced, equal, dichotomous division has taken place. In no case did I find sori on leaves bearing single blades and with a bladder at the base.

In plate 20, fig. 2, I have represented the terminal leaves in the same condition as in fig. 1, and have also shown a bladderless equal dichotomous division of leaves bearing sori. The other leaves are identical with those in fig. 1.

I had the opportunity to examine several dried specimens of *Macrocystis pyrifera* which were gathered in Peru by D. G. Fairchild in 1899, which are preserved in the Herbarium at the University of California, and found that sori are present on the single blades of bladder-bearing leaves. It is not possible to decide how far from the holdfast the specimen preserved has

been taken, but it is evident that the leaves which bear the sori are not newly formed basal ones and they must be at least three removes from the holdfast.

The other conclusion of the Misses Smith and Whitting's paper was that the reproductive bodies appeared only in the furrows of the leaves.

Cross-sections from the *Macrocystis pyrifera* gathered at Moss Beach showed that the paraphyses and the zoosporangia were arranged in unbroken layers which extend the entire breadth of the sorus and appear on both sides of the leaf. I also examined the sori of some dried specimens which were preserved in the herbarium (University of California) and found the fruit in regular layers in *Macrocystis pyrifera* from San Pedro, California, and in the same species from Peru the paraphyses and the zoosporangia were also arranged in continuous layers. No such conditions as a furrow in the leaf was found to exist. Some old wrinkled leaves suggested that possibility, but a section showed that no reproductive bodies were present.

Another specimen from Santa Cruz Beach, California, showed the same regularity of arrangement of the reproductive bodies.

The facts gained from this investigation have been quite different from those published by the Misses Smith and Whitting, for our specimens show that the sorus is not confined to the newly formed bladderless leaves alone and also that the reproductive bodies appear in continuous instead of disconnected layers only in the furrows of the leaves. The very different results obtained suggest that Misses Smith and Whitting may have worked with an entirely different species, but since they do not mention the localities from which their materials were gathered it is impossible to decide that question.

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EXPLANATION OF PLATE 20.

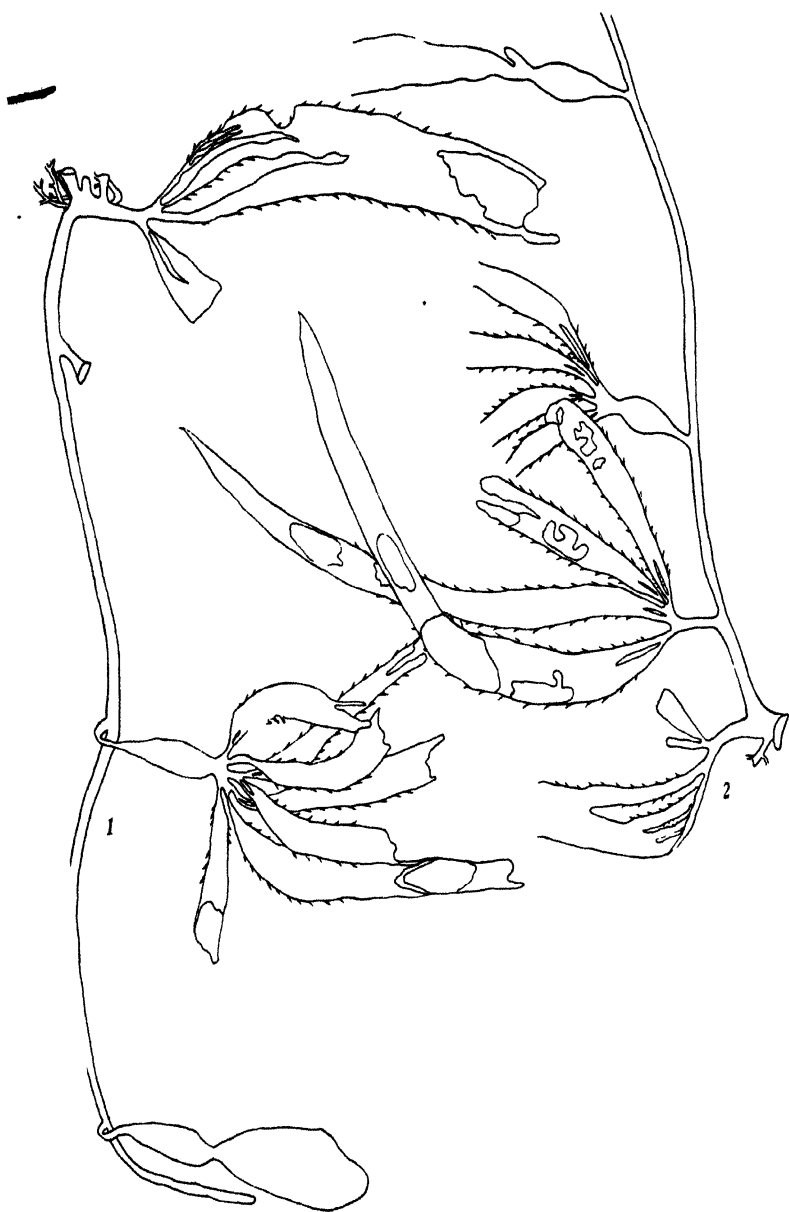
Macrocystis pyrifera (Turner) Agardh.

Tracings of specimens from Moss Beach, San Mateo County, California.

1. Basal portion of plant showing a portion of the holdfast, a basal branch with several leaves in process of formation but with a sorus, and the main stem with the basal leaf removed. A bladder bearing multilaminate leaf with sori, and a simple bladder bearing leaf without a sorus.

2. Similar portion of another plant showing the second branch from the base as having no bladders, but several blades in process of separation, some of them with sori.

Reduced to $\frac{1}{3}$ original diameter.



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ERYTHROPHYLLUM DELESSERIOIDES
J. AG.*

BY
WILFRED CHARLES TWISS.

Erythrophyllum delesserioides, a member of the Rhodophyceae inhabiting the littoral and sublittoral zones of the California coast, has been a cause of some difference of opinion among algologists, relative to its position in the group.

The plant was first described by J. G. Agardh (cf. 1871, p. 10), who came into possession of a young sterile specimen from the herbarium of J. E. Gray. Agardh recognized in it a striking form, and, on the basis of its vegetative structure assigned it to Gigartinaceae, with possible close relationship to *Callophyllis*. In 1879 (cf. p. 173, pl. 15, figs. 1-3) he published illustrations from the specimens in his possession.

Schmitz, who had also examined only sterile specimens, afterwards defined its position as doubtful, though he expressed the opinion that its probable place was among Dumontiaceae, rather than with Gigartinaceae (cf. 1897, p. 521).

As to the specimens distributed, very young plants were first sent out by F. S. Collins in 1894 (cf. Hauck and Richter's *Phyk. Univ.*, Fasc. XIII, under No. 606). The following year Mrs. J. M. Weeks distributed young plants (cf. Collins, Holden and Setchell's *Phyc. Bor.-Am.*, Fasc. I, under No. 50). In 1899 Setchell and Gibbs distributed, for the first time, mature plants,

* A thesis submitted in partial satisfaction of the requirements for the degree of Master of Arts, University of California, May, 1910, but since amplified.

upon which fruiting proliferations were formed (cf. Phyc. Bor.-Am., Fasc. XII, under No. 588). Here the cystocarps were first mentioned by Setchell, with the statement that they were Gigartinaceous in character and that the genus should, therefore, remain with Gigartinaceae, where Agardh had placed it, and not in Dumontiaceae, as suggested by Schmitz. The last distribution was by Josephine E. Tilden, who, in 1902, sent out young plants (cf. Am. Algae, under No. 505).

In 1899 Agardh published a more complete description of the sterile form which he had examined, amplifying his former statements, and reaffirming his belief in the correctness of his first classification. He then referred to the mature plant that had been distributed by Setchell and Gibbs as probably of a different genus, and proposed for it the name *Polynura californica* (cf. 1899, p. 57). As will be seen by reference to the illustrations presented herewith and to the specimens distributed as above mentioned, there is such a marked difference between the young and the mature plants that Agardh's disbelief in their identity seems somewhat justifiable (cf. Setchell and Gardner, 1903, p. 303; also, De Toni, 1895, p. 1639).

Although Setchell possessed a complete series of plants in different stages, establishing beyond a doubt the fact that the youthful and mature forms which had been distributed belonged to one and the same species, he nevertheless, in 1903, examined the specimens in Agardh's herbarium, in order to satisfy himself concerning the exact nature of the material which the latter had used in his studies. Setchell's notes are as follows:

“*Erythrophyllum delesserioides*.

No. 25374 (type and only specimen) upper portion (dimidium) from the herbarium of J. E. Gray, Vancouver Island. Characteristic young plant. See tracing.

Polynura californica.

No. 25375 (3 specimens).

Plant from Mrs. Hall, older, much split and the papillae just showing.

No. 25376. Plant from Eaton (no. 73), much eroded, with papillae.

No. 25377. A bit from P. B. A.—Later specimen *Erythrophyllum delesserioides*.”

Fig. 1 (plate 21) is a reproduction of Setchell's tracing, referred to above. Fig. 2 was drawn from a specimen similar to Agardh's older forms.

As yet, however, no careful study had been made of the structure of the fruiting proliferations, their vegetative characteristics chiefly having been taken into consideration in the previous assignments of the plant to Gigartinaeae and Dumontiaceae, respectively. Such being the state of the case, it was suggested by Professor Setchell that an investigation of the structure and development of the papillae, and more especially of the cystocarp, would be advisable, in order to establish the position of the plant more definitely. For the pursuance of this object the publications, notes, etc., above referred to, were made available, together with the collections and preserved material of the University of California.

As previously stated, *Erythrophyllum delesserioides* is an inhabitant of the litoral and sublitoral zones of the western coast of North America, of California in particular, and extending as far north as Vancouver Island, B. C. The young plant possesses a delicate leaf-like thallus, somewhat oval in outline with a slight mid-rib-like thickening along the median line. The apex of the thallus blade is rounded and the blade more or less truncate, with or without a short stipe connecting it with a discoid holdfast. The margin is wavy, generally more or less incised by an oblique splitting toward the base and toward the median line. The color of the plant, in its natural habitat, is brick red, changing to a dark ruby hue in the preserved material. The consistency is firm gelatinous, but not hard or horny, as in the case of *Gigartina mamillosa*, for instance. The proportions found in a moderately young plant were as follows: length, 5 cm.; width, 2 cm.; stipe, 5 cm. An older plant had a length of 18 cm. and a width of 4.5 cm., was greatly incised along the margin, and showed a much stronger development of the mid-rib-like thickening of the median line than was found in the young plant. A few incipient branches of the mid-rib had been developed, which, proceeding toward the margin and projecting forward and outward at an acute angle, served as supports for the lobes formed by the in-

cisions above mentioned. These lateral lobes are often themselves incised, and their ribs branched, as in the case of the main rib. In older specimens dichotomous branching of the main rib may occur. Often a number of separate blades were found, originating at or near the holdfast, or, where the stipe was elongated, at a distance of 5 cm. or more from the point of attachment. The above measurements are intended merely to indicate the proportions found in growing plants. A much larger growth is eventually attained, some of the specimens at hand having a length of 30 cm. or more.

As the season advances, the incisions increase in number and the edges of the thallus blades become more or less worn away, so that by the time the papillae are fully developed, the plant has assumed a somewhat attenuated appearance with a comparatively narrow, truncated blade, and a much greater proportional development of stipe, mid-rib and lateral branches.

The final stage, as seen in specimens gathered in January, consists of scarcely more than the mid-rib and its lateral branches which are still covered, and that, too, very densely, with papillae.

The papillae, to be described more particularly later, are minute proliferations, somewhat rounded terminally in the case of the cystocarpic, and elongated or thumb-shaped, in that of the tetrasporic. Antheridial plants have not yet been observed.

During the following spring the plants are broken or worn down to mere fragments, attached to the rocks by their holdfasts. As summer advances, these fragmentary stipes may send forth proliferations which become thallus blades, similar in all respects to the young plants produced from spores. Nine such vegetatively reproduced fronds were found upon a piece of old stipe 5 cm. long.

With reference to plates 21-24 appended to this paper, figs. 3 and 4 represent stages in the development of the plant before the papillae have begun to appear. Fig. 5 shows a small cystocarpic plant, thickly covered with papillae. Fig. 6 shows a segment of a similar frond, on a larger scale.

Proceeding to the internal structure of the thallus, fig. 8 represents a longitudinal section perpendicular to the surface of

the blade. There is a central area, consisting of long, narrow, coarsely granular cells, arranged in series to form filaments. These filaments run in a generally parallel direction with reference to the surface of the thallus, slightly interlacing and connected among themselves by short cross-branches. They occasionally branch dichotomously. Scattered among them are other long, branching and connected cells, the contents not perceptibly granular but staining deeply with fuchsin, similar to the carogenous cells of the cystocarp, to be described later.

Outside of this central skein of elongated cells is a region consisting of rather short, linear cells arranged in an irregularly branching formation and tending toward the cortical layer at various angles. Interspersed among these are numerous large, oblong and spheroidal cells of granular content, connected with each other and with the surrounding linear cells by pits. The outer cortical layer originates in medium-sized spheroidal cells from which arise, by a dichotomously branching arrangement, the small oblong cells of the anticlinal rows. These anticlinal rows are very short in the young frond, consisting of but one or two cells. Later, the number of cells increases to four or five, or more, making the outer cortical layer proportionately thicker. Conversely, the larger irregular cells of the inner cortical layer, referred to above, are less numerous in the older fronds and in the stipe, so that there is ultimately but little separation between the central skein of elongated cells and the outer cortex. The chlorophyll and red coloring matter of the plant is resident in the cells of this outer layer.

A cross-section of the thallus shows the cut ends and some of the lateral surface of the nearly perpendicularly arranged cells of the central structure, interspersed with the previously mentioned cells of homogeneous content which stain deeply. Outside of this are the smaller cells in a somewhat reticular arrangement interspersed with large and irregular ones, presenting very much the same appearance that they do in the longitudinal section, as do also the cells of the outer cortical layer. The whole structure has the same character in the mid-rib portion as it does in the flat thallus blade, the only difference being that the central

skein is wider, measuring in a direction perpendicular to the face of the blade, in order to produce the mid-rib-like thickening.

The fruiting proliferations are borne at any point upon the surface of the thallus, generally in such abundance as to appear crowded together. This is especially true of the tetrasporic proliferations, which give to the fronds upon which they grow a plush-like appearance and feeling. The tetrasporic proliferations are easily distinguished from the cystocarpic by their somewhat greater length and smaller diameter. They taper gradually toward the base and toward the more or less bluntly pointed apex. Their length varies from $\frac{3}{4}$ to 1 millimeter, or more. Their width is, in general, from $\frac{1}{4}$ to $\frac{1}{3}$ millimeters. The internal structure is rather loose, consisting of short cells in the contracted, or neck portion, and larger, longer cells constituting filaments running longitudinally to the apex. The cortical layer is similar to that of the frond, the tetrasporangia themselves being simply differentiated cells of the outer cortical layer, much enlarged, ellipsoidal in shape and irregularly divided by planes oblique to their longitudinal and transverse diameters. They may be clearly seen with a $\frac{2}{3}$ -inch objective, appearing as dark red bodies among the lighter colored cortical cells of the proliferation. Fig. 7 is a diagrammatic representation of a small thallus lobe, bearing tetrasporic proliferations. Fig. 9 is a drawing from a longitudinal section of a proliferation, showing the tetrasporangia in position, together with a still further enlarged view of the same, free from the proliferation.

The cystocarpic proliferations are somewhat shorter, and considerably thicker than the tetrasporic and lighter in color. They are borne upon separate plants from those which produce the tetraspores. Though the vegetative structure is identical, the cystocarpic plants may readily be recognized by noting the characteristics of the fruiting proliferations with a hand-lens.

In the development of the cystocarp an elevation of the cortical layer of the thallus is first noted, proceeding from a lateral growth of cells from the central structure of the frond. This elevation progresses to the formation of a young cystocarpic proliferation which has, at first, a structure resembling that of

the thallus. As the proliferation lengthens a secondary stage is reached in which a marked differentiation of the cells appears, many of them enlarging and becoming filled with a coarsely granular protoplasm and connecting with each other by pits of relatively large diameter. The next stage is marked by the beginnings of the carpogenic branches, arising from the cells of the inner cortex. From these groups come finally the gonimoblast filaments from which are produced the spores. Fig. 10 is a drawing from a paraffin section, stained with fuchsin, showing parts of various carpogenic cells, with groups of spores separated by partitions of vegetative cells.

The carpogenic branch consists, primarily, of three large, irregularly oblong cells, connected at their smaller ends by pits. The larger ends are broad, with a tendency to form more or less distinct lobes. The series is continued by two smaller, curved, rather narrow cells, connected by pits with each other and with one of the larger cells above mentioned (cf. fig. 11). Joined to the last small curved cell by a pit from its base, is a minute triangular cell, the apex being prolonged into a filiform extension, which, after making a spiral turn, joins at right angles a lateral off-shoot from the base of the trichophore (cf. fig. 11). The trichophore is of comparatively large size in its lower portion, gradually contracting above to form the trichogyne. The latter makes its way through the cells of the cortical layer and the gelatinous coat of the proliferation, beyond which it is but slightly prolonged.

After fertilization, presumably, though this process has not as yet been observed by the writer, the trichophore sends out a filament from its basal portion, upon the side opposite the extension which connects with the small triangular cell above mentioned (cf. fig. 11).

This filament was observed in various stages of development, varying from a mere protuberance upon the side of the trichophore, up to and exceeding the relative length represented in fig. 11. A fusion of this tube from the procarp with one of the large carpogenous cells was noted in several instances, yet, owing to the fact that the cells became more or less detached from each

other, and their relative positions altered, in the crushed preparations employed, it has not been possible, so far, to determine with which one of the carpogenous group this fusion takes place. The indications, however, appear to denote a union with the basal cell.

Furthermore, a fusion of the three large carpogenous cells occurs as represented in fig. 12. Whether this fusion takes place as a preliminary to the formation of gonimoblast filaments, or whether it only happens in the absence of fertilization, as Schmitz says is the case in *Callymenieae* (1897, p. 355), we are unable, as yet, to say. At all events, large irregular, usually tripartite cells finally arise from the carpogenous group, from which proceed a profusion of filaments (cf. fig. 13). These large irregular cells appear to have their origin in the fusion of the three cells above referred to, though instances were not wanting in which but one of the group seemed to be responsible for their formation. From the fact that the instances in which an unmistakable fusion of the three large carpogenous cells occurred were very numerous it is probable that the former is the case, and, also, that the gonimoblast filaments arise from these. As the final determination of this point, however, is not vital to this paper, its further investigation has been deferred.

The gonimoblast filaments, arising from the carpogenous groups, run inward for the most part, toward the center of the proliferation. The carpospores were seen to be connected in some cases with filaments, while in others they were gathered together in groups, without apparent connection with each other or with filaments. As these carpospores finally become very numerous in the proliferation and as they are packed closely together in groups on account of being developed from a number of carpogenic branches acting independently, they push the vegetative cells together, forming partitions, as it were, between the various aggregations. The so-called compound cystocarp, characteristic of *Gigartinaceae*, is thus produced (cf. fig. 14). The development of the spore groups is principally inwards, as just stated, and there is little or no compression of the vegetative cells surrounding the fruit body, to form a filamentous coat. Another *Gigartinaceous* feature is seen in the not infrequent branching of

the cystocarpic proliferation, and the formation of fruit bodies in each division.

In the figure last referred to, the manner of freeing the spores is also shown. In the course of its development the wall of the fruiting proliferation becomes distended more upon one side than upon the other. Upon this distended side the cortex is thinner, especially toward the apex of the proliferation, where it consists, ordinarily, of but the outer cortical layer with one or two rows of small cells. This thin portion of the wall of the proliferation finally breaks down, allowing the escape of the spores. No carpogones are present.

In conclusion, it would appear that *Erythrophyllum delesserioides*, by virtue of the character of its fruiting proliferations, its so-called compound cystocarp with spore-groups separated from each other by partitions of vegetative cells, and by virtue of its vegetative structure, belongs among the Gigartinaceae, as Agardh at first stated. Furthermore, the character of the carpogonic branch and the method of spore formation only strengthens the belief, which the vegetative structure at once suggests, that its place, according to the present classification, is very near to the Callymenieae. In fact, it would seem that Schmitz's description of the carpogonic branch and the manner of spore production in *Callophyllis* would apply almost equally well to *Erythrophyllum delesserioides*.

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EXPLANATION OF PLATES.

Figures from freehand drawings by the writer.

PLATE 21.

Fig. 1.—Drawn from Setchell's tracing of Agardh's type specimen.

Fig. 2.—From a fragment of an old plant of *Erythrophyllum delesserioides*, similar to Agardh's later specimens, assigned by him to *Polyneura californica*.

Fig. 3.—From a specimen in the University of California herbarium, showing a younger stage in the vegetative development of *Erythrophyllum delesserioides*, before the formation of papillae.

Figs. 1, 2, 3, natural size.

Fig. 1.

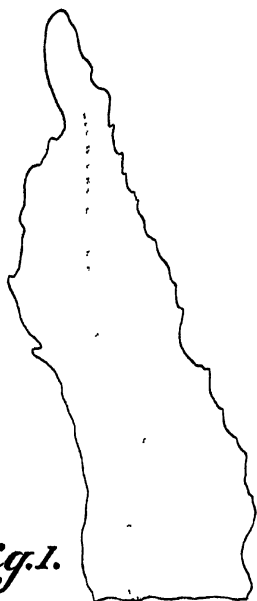


Fig. 2.



Fig. 3.

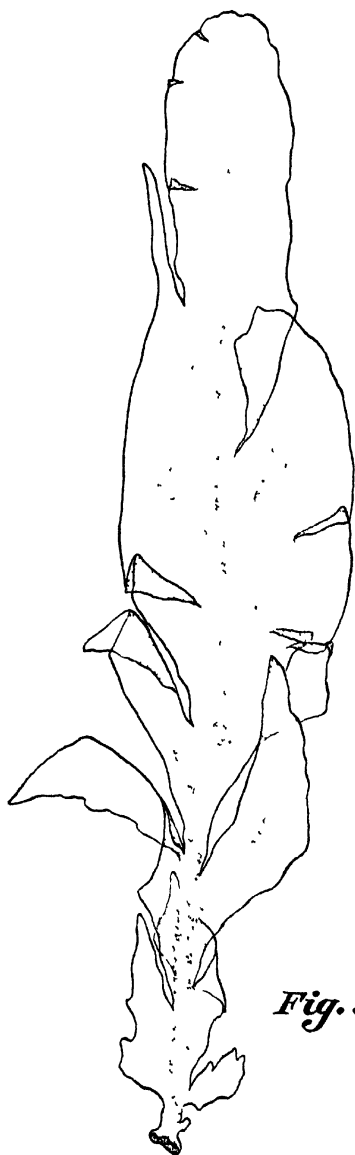


PLATE 22.

Fig. 4.—Showing a plant which has reached full vegetative development, but as yet without papillae.

Fig. 5.—From a still older, comparatively simple specimen of the same, showing the development of papillae in the cystocarpic plant. The tetrasporic fronds are similar in appearance.

Figs. 4, 5, reduced $\frac{1}{4}$.

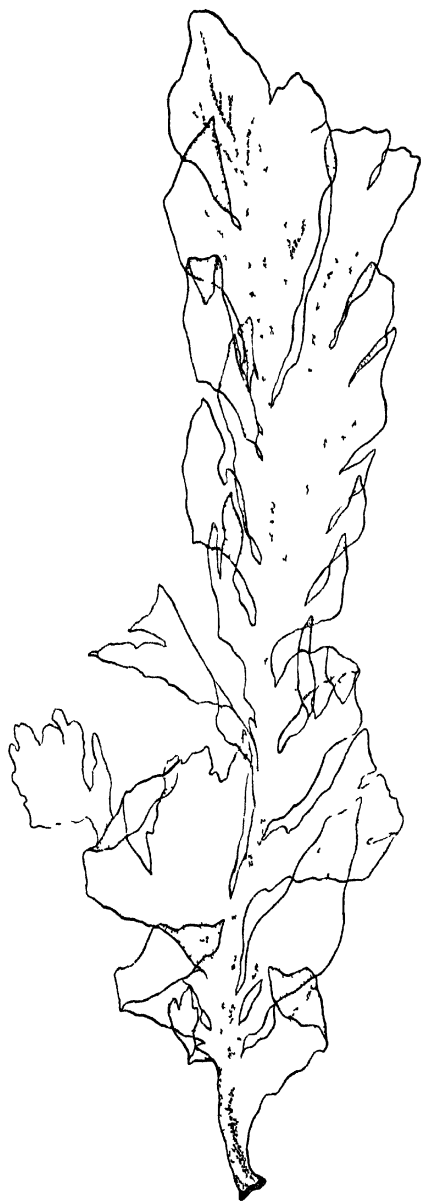


Fig. 4.

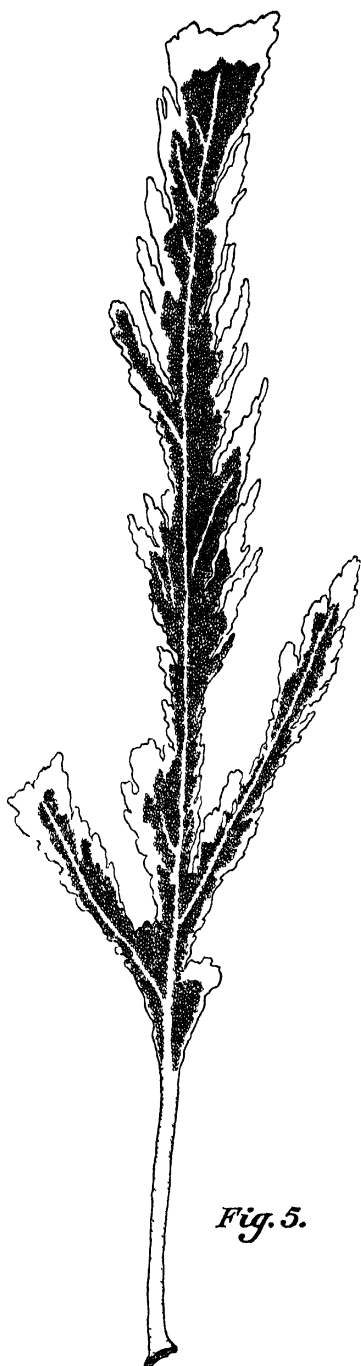


Fig. 5.

PLATE 23.

Fig. 6.—Segment of the above, enlarged.

Fig. 7.—Drawn from a paraffin cross-section of a very small tetrasporic frond, showing papillae in longitudinal section. Enlarged 10 times. Diagrammatic.

Fig. 8.—From a frozen longitudinal section, representing the structure of the vegetative frond with its central skein of interlaced filaments, among which is one of the larger cells which stain deeply; the inner cortex, with its large granular and short rhizoidal cells; and the outer cortical layer, with its rows of anticlinal cells.

Fig. 9.—From a longitudinal section of a paraffin preparation of the tetrasporic proliferation, showing the tetrasporangia in position in the outer cortical layer. Upon the left, the tetrasporangia are shown enlarged.

Fig. 6, enlarged $\frac{1}{3}$. Fig. 7, enlarged 10 times.

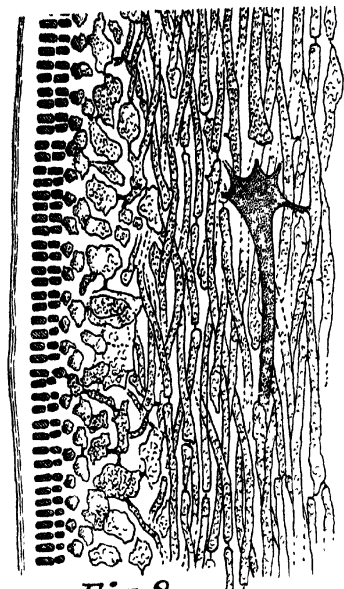


Fig. 8.

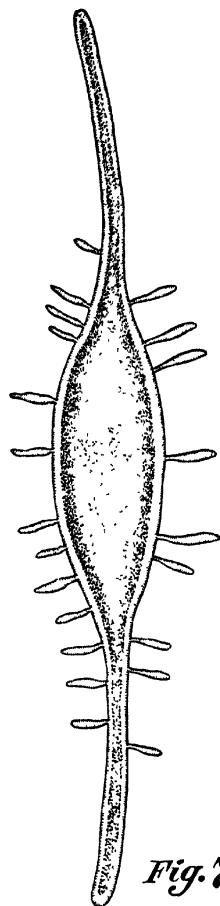


Fig. 7.

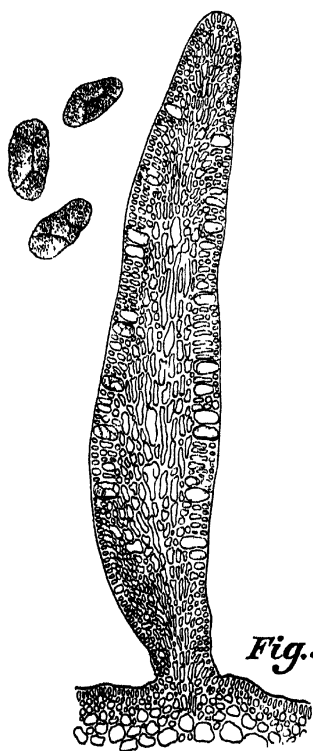


Fig. 9.

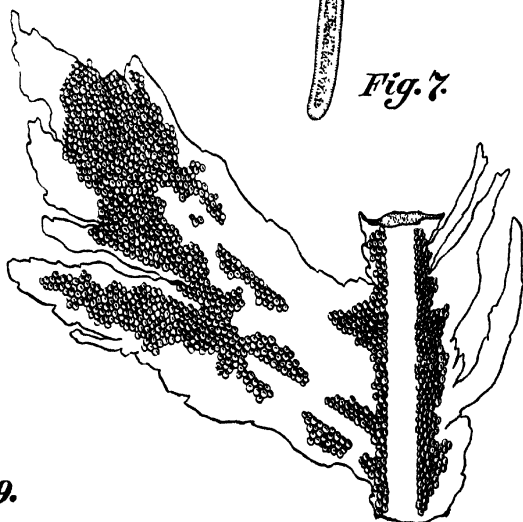


Fig. 6.

PLATE 24.

Fig. 10.—From a longitudinal section of a paraffin preparation of the cystocarpic proliferation, showing parts of carpogenous groups near the cortex of one side and early stages of spore groups.

Fig. 11.—Carpogenic branch with trichophore, showing conjugating tube which is produced in case of fertilization. This is a composite drawing made from numerous sketches of crushed material, stained with fuchsin. Though more or less apparent variation was observed in the carpogenic group, these are the forms of the individual cells occurring most constantly, and may, therefore, be regarded as typical.

Fig. 12.—Showing fusion of large cells of carpogenic branch, analogous to that which takes place, according to Schmitz, in *Callophyllis*, in the absence of fertilization. From crushed preparation, stained with fuchsin.

Fig. 13.—From a similar preparation, showing the tripartite body which results presumably from a later stage of the fusion depicted in Fig. 12. The old trichophore, and what seems to be the conjugating tube, are seen above.

Fig. 14.—Drawn from a longitudinal section of a paraffin preparation of the mature cystocarp, showing the dense masses of spores, separated by partitions of vegetative cells. The outer cortical layer is seen breaking away to allow the escape of the carpospores.

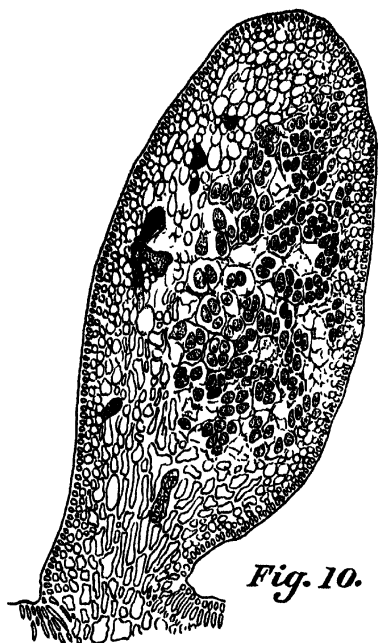


Fig. 10.

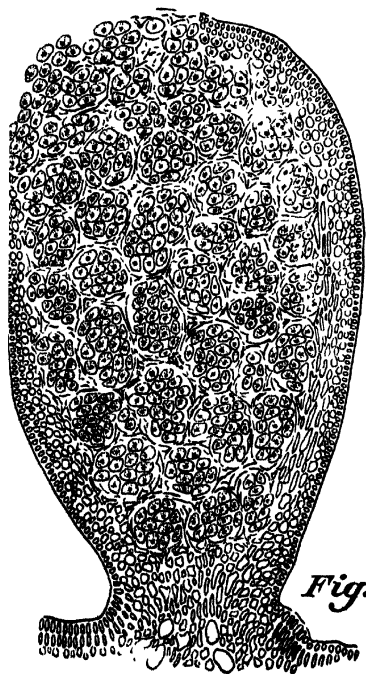


Fig. 14.

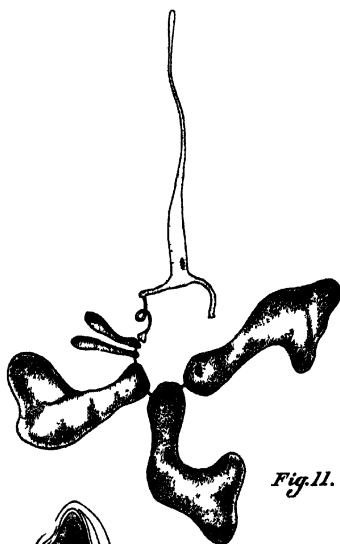


Fig. 11.

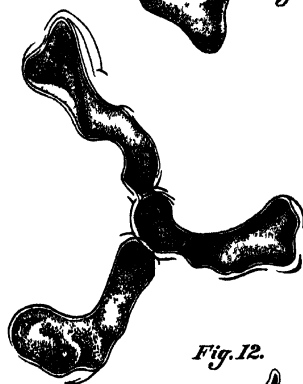


Fig. 12.

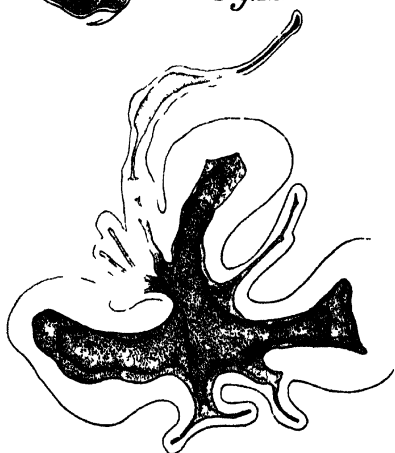


Fig. 13.

PLANTAE MEXICANAE PURPUSIANAE, III

BY

T. S. BRANDEGEE.

The collection of Mexican plants made by Dr. Purpus in 1910, in addition to the following new species, contains many that are rare and interesting. The range of many, especially those belonging to Arizona and Texas, is extended; for example, *Gilia aggregata*, *Salvia farinacea*. Many rare plants were found for the second time, among which may be mentioned *Tridax candidissima*. Some of the localities should be more definitely located. Sierra de la Paila is in the region of Parras (Cerro del Rey, Cerro de Zapatero, Cerro de San Ignacio, Cerro Barbecoa, Cerro de Cypriano, are all near the Hacienda Movano and along the boundary line between Coahuila and Durango.

***Muilla Purpusii* sp. nov.**

Cormus diametro ca. 15 mm., brunneotunicatus. Scapus basi hispidus ca. 2 dm. altus. Folia graminiformia scapo breviora. Umbellula basi bracteosa, pedicellis ca. 3 cm. longis. Perianthii segmenta 9 mm. longa, oblongo-lanceolata, margine caerulea, dorso viridi-costata. Tubus brevissimus; filamentis caeruleis ad faucem tubi adnatis, antheris oblongis versatilibus, capsulis sessilibus, loculis 3-5-spermis.

The color of the flower is blue with green in the center of the perianth-segments. The perianth is rotate when fully expanded. Collected on Sierra de la Paila, Coahuila. No. 4959. Type, Herb. Univ. Calif., No. 148555.

***Drymaria axillaris* sp. nov.**

E radice ramoso multicaulis, 6–10 cm. alta, undique viscosa puberulaque: foliis quam internodiis brevioribus, late ovatis subito acuminatis, crassis, usque 10 mm. longis, 5 mm. latis; petiolis ca. 1 mm. longis; floribus solitariis bracteatis racemosis, bracteis quam internodiis longioribus foliis similibus sed minoribus; pedicellis ca. 4 mm. longis; petalis 4 mm. longis ad medium bifidis, sepala ovato-lanceolata margine alba vel rosea aequantibus; staminibus 5; stylo breviter trifido; capsula oblonga quam sepalis brevior; seminibus minute reticulatis demum fuscis.

Related to *D. polycarpoides*, also collected in the same region by Dr. Purpus, but easily separated from it by its viscous pubescence and leaf-like bracts. Although described as an annual *D. polycarpoides* is perennial. Both species grow from a deep branching root and specimens with only the upper slender part appear annual. Collected on Sierra del Rey, Coahuila. No. 4526. Type, Herb. Univ. Calif., No. 144769.

***Thelypodium lobatum* sp. nov.**

Herbaceum e radice lignosa, caulibus ca. 3 dm. altis, basi hirsutis, superne stellato-hirsutis; foliis inferioribus 8 cm. longis, utrinque hirsutis, pinnati-partitis, segmentis oblongo acutis reflexis, 15 mm. longis, 5 mm. latis, petiolis ca. 2 cm. longis, foliis superioribus brevioribus; floribus albis, pedicellis 5 mm. longis; racemis 5 cm. (magisve) longis, ebracteatis; stylo brevi; stigmate capitato deinde bilobato; siliquis teretis, sessilibus hirsutis, 2 cm. longis.

Like pinnatiparted leaves generally, those of this plant are very variable in shape. Often the lobes extend to the rhachis and sometimes the rhachis is margined between the lobes. The lobes of the upper leaves become almost filiform. Collected on Sierra de Parras, Coahuila. No. 4561. Type Herb. Univ. Calif., No. 148556.

***Thelypodium versicolor* sp. nov.**

Glabrum, 4–6 dm. altum; foliis caulinis sessilibus, basi auriculatis, margine integris, obtusis, 1–4 cm. longis, 0.5–1.5 cm. latis;

foliis radicalibus spatulatis, margine serratis ciliatis ca. 4 cm. longis, 5–10 mm. latis; petalis 5 mm. longis, fere albis, quam sepalis violaceis duplo longioribus; siliquis 16 mm. longis erectis; pedicellis ca. 16 mm. longis.

The mature siliques are torulose and erect or sometimes slightly spreading. The different colors of the petals and sepals make a pleasing contrast. Collected on Sierra de Parras, Coahuila. No. 4978. Type, Herb. Univ. Calif., No. 146806.

***Psoralea oligantha* sp. nov.**

Herbacea fere glabra, caulibus ca. 1 dm. longis; foliis 4–6 cm. longis, trifoliolatis, foliolo terminali late ovato acuminato, basi cuneato, ca. 2.5 cm. longo, 1.5 cm. lato; foliolis lateralibus minoribus fere sessilibus;; foliis inferioribus minoribus saepe foliolis orbiculatis; floribus capitatis, pedunculis quam foliis longioribus; calyce 7 mm. longo, infra medium fere aequaliter 5-lobato; corolla violacea; legumine immaturo obliquo-ovato.

This species is near *P. rhombifolia*, it has leaflets of the same shape but is nearly glabrous, the upper leaves have long petioles and the legume does not have the long beak of *P. rhombifolia*. The pod of *P. rhombifolia* is circumscissile above its base falling with the enclosed seed. Collected at high elevations on Sierra de Parras, Coahuila. No. 4583. Type, Herb. Univ. Calif., No. 144765.

***Dalea sabulicola* sp. nov.**

Verisimiliter annua, caule 3–5 cm. alto, hirsuto; foliis paucis ca. 2.5 cm. longis, dense hirsutis; foliolis usque 4-jugis, obovatis acutis basi cuneatis; capite cylindraceo, 3–5 cm. longo; bracteis lineari-lanceolatis, margine apiceque hirsutis, calycis tubum superantibus; calycis dentibus setaceis tubo duplo longioribus, longe hirsutis; floribus violaceis.

Collected on Sierra de la Paila, Coahuila, growing in gravelly soil. No. 4740. Type, Herb. Univ. Calif., No. 148289.

***Dalea parrasana* sp. nov.**

Caulibus e radice lignosa 5–12 cm. altis, strigoso-hirsutis; foliis ca. 2 cm. longis, hirsutis; foliolis 3–4-jugis, oblongo-ovatis,

apice acutis, basi cuneatis; stipulis filiformibus; capitibus 3-4 cm. longis; bracteis late ovato-acuminatis, longe ciliatis; calycis dentibus 7 mm. longis, setaceis, longe sericeo-villosis; floribus flavis.

This species has short stems and a stout woody root. The heads are large for the size of the plant and the long broadly lanceolate bracts are very conspicuous. No. 4741, collected on Sierra de Parras, Coahuila. Type, Herb. Univ. Calif., No. 148240. Dr. Purpus collected it near Parras in 1905, but not in quantity for distribution.

***Dalea quinqueflora* sp. nov.**

Frutex ramosus glaber, cortice fusco; foliis ca. 8 mm. longis, 4-jugis; foliolis 3 mm. longis, 0.5 mm. latis, oblongis obtusis, utrinque glanduliferis; capitibus saepe 5-floris, floribus flavis, bracteis glabris latis, amplexis; pedunculo 7 mm. longo; bracteis acutis, obscure glanduliferis; calyce sericeo-pubescente, 5 mm.

This species is well marked by its few-flowered heads and especially by the broad persistent bract which enwraps each flower. Collected at Buena Vista, San Luis Potosi. No. 4837. Type, Herb. Univ. Calif., No. 148416.

***Eysenhardtia parvifolia* sp. nov.**

Fruticulus cortice fusco; foliis 12 mm. longis puberulis; foliolis 4-6-jugis, ovatis, ca. 2 mm. longis, punctis glandulosis conspersis; racemis 5-10 mm. longis, lignosis, paucifloris; bracteis diu persistentibus, subulatis 2 mm. longis; vexillo parum emarginato; staminibus connatis; stylo eglanduloso apice uncinato; ovario 2-ovulato, ovulis superimpositis; legumine glanduloso-punctato, stricto, ca. 8 mm. longo, 2 mm. lato, 2-spermo.

The specimens are from an intricately branched bush. The species is nearest *E. spinosa*, but has a very different pod. Collected on Sierra de Parras, Coahuila. No. 5074. Type, Herb. Univ. Calif., No. 150014.

***Eysenhardtia peninsularis* sp. nov.**

Frutex cortice fusco glabro; foliis 10-15 mm. longis, puberulis; foliolis obovatis vel oblongis, ca. 5 mm. longis, 5-jugis;

racemis 2-5 cm. longis, rhachi albopubescente; bracteis diu persistentibus, spinosis; calycibus pubescentibus; vexillo parum emarginato; stylo apice uncinato, glanduloso. Legumen ignotum.

This species is an intricately branched shrub easily distinguished from *E. amorphoides* by its spinose bracts. Collected in Baja California by T. S. Brandeggee and listed in Proc. Cal. Acad., 2nd Ser. II, 148, as *E. spinosa*. Type, Herb. Univ. Calif., No. 83928.

***Rhynchosia potosina* sp. nov.**

Caules erecti vel volubiles, ramosi, striati, 3-4 dm. alti, pubescentes: foliis trifoliatis, ca. 8 cm. longis, foliolis lateralibus inaequilateralibus, late ovatis acutis subtus hirsutis reticulatis; foliolo terminali, quam lateralibus majore, ca. 3 cm. longo, 2.5 cm. lato; racemis axillaribus, paucifloris: calyce campanulato, flavo-hirsuto, 5-dentato; floribus flavis; vexillo dorso pubescente; legumine hirsuto, ca. 2.5 cm. longo; seminibus orbiculis alba notatis.

Collected on a high sierra near Guascama and Agua Media, San Luis Potosi. No. 4845. Type, Herb. Univ. Calif., No. 148386.

***Fagonia scoparia* sp. nov.**

E radice lignosa multicaulis, erecta ramosa aphylla ca. 15 cm. alta: pedicellis 5-10 mm. longis; sepalis ovato-acuminatis quam petalis duplo longioribus, acuminatis roseis; ovario dense albosericeo hirsuto; stipulis minutis tenuis.

This plant grows in broom-like clumps with fragile branches easily breaking at the joints. The old leaves of *F. californica* are deciduous, but with all the numerous specimens of the University of California Herbarium even when old enough to have lost all flowers and fruit some leaves persist. The specimens of *F. scoparia*, although they have flower buds and young shoots, show no sign of a leaf. Collected on Cerro del Macho, Coahuila. No. 4495. Type, Herb. Univ. Calif., No. 143345.

***Linum macradenium* sp. nov.**

Multicaule e radice lignosa, caulibus ca. 3 cm. altis, hirsutis, ramosis; foliis oblongo-lanceolatis acutis vel obtusis, apice

saepissime cum glandula magna instructis, subtus pubescentibus, supra glabris; glandulis stipularibus; petalis flavis cuneato-oblongis, 1 cm. longis; calycis lobis ovato-acuminatis, nervo medio prominente, margine dense glanduloso-cilatis: stylis liberis: pedicellis ca. 3 mm. longis: capsula acuta calycem superante.

This species is nearest *L. scabrellum*, but is more glandular and hirsute. The large glands are abundant on the upper leaves and bracts. Collected at Minas de San Rafael, San Luis Potosi, No. 4923. Type, Herb. Univ. Calif., No. 148804.

***Echinopterys setosa* sp. nov.**

Fruticosa, ramosa, caulibus hirsutis cinereis; foliis oblongo-obovatis basi angustatis, fere sessilibus, utrinque glabris, ca. 1 cm. longis, 2 mm. latis: pedicellis ca. 1 cm. longis: stylis apice coalitis: fructuus setis saepissime rectis glabris.

This differs from *E. eglandulosa* in having the styles united only at the apex and the bristles of the fruit stouter and not plumose, otherwise it is very much like it. Collected on Sierra de la Paila, Coahuila. No. 4950. Type, Herb. Univ. Calif., No. 148802.

***Helietta lucida* sp. nov.**

Frutex cortice fusco, ramis juvenibus puberulis; foliis trifoliatis, petiolis 2–4 cm. longis puberulis, foliolo terminali 7–11 cm. longo, ca. 2.5 cm. lato, ovato-lanceolato, basi cuneato, glabro, lucido reticulato, margine integro, foliolis lateralibus similibus minoribus; fructu alas includente 3 cm. longo, pubescente, alis 4–5 reticulatis, apice rotundatis; stylo persistente capitato. Flores desunt.

The few specimens collected were fruiting. The leaves are shining papyraceous and conspicuously reticulated. Collected in the vicinity of San Luis Tultitlanapa, Puebla. No. 4451. Type, Herb. Univ. Calif., No. 143302.

***Polygala magdalenae* sp. nov.**

Caules basi lignosi, pauciramosi pubescentes striati 1–3 dm. alti: foliis nunc oblongo-ovatis nunc lineari-lanceolatis puberulis petiolatis, 1–2 cm. longis, 2–8 mm. latis: racemis terminalibus

laxifloris; floribus mediocribus ochroleucis; sepalis lanceolatis pubescentibus; alis late ovatis subunguiculatis margine ciliatis; petalis superioribus cum tubo staminali per dimidium connatis, late linearibus, apice dilatatis obtusis, quam carina $\frac{1}{3}$ brevioribus; ovario ovato piloso; stylo curvato, stigmate superiore ab alio paullo separato; staminibus 7; capsula oblonga, late marginata apice emarginata pubescente, 7 mm. longa, 6 mm. lata; semine pyriformi 4 mm. longo, compresso piloso, arillo corneolo capitelliformi margine papyraceo undulato.

This species has been noted in lists of Lower California Plants as *P. xanti* and *P. puberula*, from both of which it is very distinct. It is near *P. leptosperma*, but differs in the shape of the capsule, the relative position of the stigmas and shape of the superior petals. *P. Xanti* is a prostrate plant, with wings exceeding the keel and the base of the flower is conspicuously gibbous. *P. magdalenae* has been collected by the writer at Magdalena and Santa Margarita islands, Todos Santos of the Cape Region and San Jose del Cabo, all in Baja California. Herb. Univ. Calif., Nos. 109758, 109749, 137739, 109756, 133558.

***Polygala nudata* sp. nov.**

Multicaulis e radice lignosa, caulibus ca. 15 cm. altis, basi frutescentibus, fere glabris: foliis paucis bracteiformibus sessilibus acutis: racemis terminalibus ca. 6 cm. longis paucifloris reetis: floribus ca. 4 mm. longis albis: sepalis ovatis acuminatis viridibus, alis ovato-oblongis: petalis superioribus oblongis apice dentatis: carina cristata, crista cornuta integra oblonga: capsulis oblongis glabris: seminibus ovali-oblongis, pilis sericeis vestitis; carunculis corneis bidentatis, dentibus perpendicularibus brevibus.

Compared with the figures of *P. arizonae* in Chodat's *Monograph of Polygalaceae*; the wings are nearly alike, the superior petals dentate instead of entire, the capsule with the persistent sepal is the same but less notched at the top, the caruncle is very different and the rhachis is not zigzag. The hornlike crest is short and the plant has the appearance of being leafless. Collected on Sierra de la Paila, Coahuila. No. 4762. Type, Herb. Univ. Calif., No. 148239.

***Euphorbia collina* sp. nov.**

Caules ramosi basi lignosi dense glanduloso-pubescentes, ca. 18 cm. alti: foliis oppositis breviter petiolatis rotundo-ovatis, ca. 5 mm. longis, 3-4 mm. latis, margine glanduloso-ciliatis: involucri ca. 1 mm. longis solitariis in axillis foliorum ramorum brevium, quam pedicellis longioribus, pubescentibus turbinatis; glandulis 4 stipitatis oblongis fuscis parvis concavis, appendice alba vel rosea oblongo-rotundata ca. .5 mm. longa lataque; capsulis pubescentibus, coccis carinatis, pedicellis a latere fisso involucri deflexis; stylis ad medium bipartitis; semine cinereo oblongo tetragono crasse rugoso, angulis acutis crenatis.

All the specimens collected are mature and many of the leaves are rose-colored. Dr. William Trelease obligingly compared this species with *E. arizonica* and assures me that it is very distinct from it. Collected on Cerro de San Ignacio, Durango. No. 4599. Type, Herb. Univ. Calif., No. 144767.

***Euphorbia scopulorum* sp. nov.**

Fruticosa ramosissima, ramis albo-pubescentibus: foliis oppositis fere sessilibus, e basi inaequali, ovato-acuminatis crassis, margine revolutis, nervo medio subtus prominulo, ca. 6 mm. longis, 3-4 mm. latis, dense pubescentibus; stipulis brevibus lineari-lanceolatis: involucri solitariis axillaribus campanulatis, 1.5 mm. longis; pedicellis 0.5 mm. longis; glandulis 4, orbiculatis, appendice alba 4-dactyliforme: capsula pubescente trigona; semine tetragono cinereo laevi, 1.5 mm. longo; stylo brevi ad medium bifido.

The bases of the stems are woody and come from a stout ligneous root. Collected on Cerro de Cipriano, growing in crevices of rocks. No. 4513. Type, Herb. Univ. Calif., No. 143272.

***Sida potosina* sp. nova.**

Suffruticosa, caulibus 3-4 dm. altis, basi ramosis, stellato-pubescentibus; foliis ellipticis crenato-dentatis, utrinque pubescentibus; petiolis 2-10 mm. longis: floribus solitariis axillaribus; pedunculis 5-9 cm. longis; corolla flava 15 mm. lata; calycis

segmentis deltoideis pubescentibus; bracteolis nullis; carpellis ca. 10, muticis.

This is a species having many branching stems woody at base. The flowers are on very long peduncles arising from the axils of the upper leaves and much surpassing them. Collected at Minas de San Rafael, San Luis Potosi. No. 4906. Type, Herb. Univ. Calif., No. 148803.

Vincetoxicum (Chthamalia) camporum sp. nov.

Caules pubescentes erecti, 2-3 dm. longi: foliis profunde cordatis longe acuminatis usque 4 cm. longis, 2.5 cm. latis: pedunculis 5-10 mm. longis 2-5-floris. calycis lobis oblongo-ovatis acutis parce pubescentibus: corolla campanulata virido-purpurea reticulata, 7 mm. longa, intus glabra extus pubescente: stigmatibus vertice depresso, corona crateriformi basi columnae affixa, margine cum ligulis basi callosis stigma superantibus instructa: folliculis ignotis.

This species differs from *Gonolobus bifidus*, which it much resembles in having the ligules of the corona entire and the ovate lobes of the corolla glabrous within. Collected on plains near Movano, Coahuila. No. 4484. Type, Herb. Univ. Calif., No. 143287.

Breweria multicaulis sp. nov.

Undique sericeo-albo-tomentosa, multicaulis e radice lignosa, 2-4 dm. alta: foliis sessilibus lanceolatis acuminatis, basi cuneatis, 15-20 mm. longis, 4-5 mm. latis: pedicellis 5 mm. longis in axillis foliorum superiorum solitariis, bracteis aequantibus: sepalis ovato-acuminatis 1 cm. longis: corolla 3.5 cm. longa, diametro 3 cm., caerulea: stylo ad medium bipartito; ovario sericeo-hirsuto; semine abortu unico.

This plant is nearest to *B. ovalifolia*, a prostrate species with cordate leaves. Collected near Sierra del Rey, Coahuila. No. 4457. Type, Herb. Univ. Calif., No. 143306.

Phacelia (Euphacelia) arenicola sp. nov.

Viscido-pubescent, caulibus ramosis suffrutescentibus 4-5 dm. altis: foliis late ellipticis margine profunde crenatis, superioribus sessilibus: spicis 5-12 cm. longi paullo cymosis: floribus

fere sessilibus: calycis lobis obovatis acuminatis 2.5 mm. longis parce hirsutis; corolla albo-purpurea 5 mm. longa, staminibus longe exsertis; stylo ultra medium partito; capsula globosa calycis lobos aequante; seminum testis areolato.

This species in its general appearance resembles *P. caerulea*. Collected growing in sand at El Toro, near Movano, Coahuila. No. 4458. Type, Herb. Univ. Calif., No. 143334.

***Nama Purpusii* sp. nov.**

Suffrutescens albo-hirsutum foliosissimum; foliis angustolinearibus obtusis, 2.5 cm. longis, sessilibus, marginibus revolutis; floribus ramos breves axillares terminantibus; sepalis obtusis sursum parum ampliatis; corolla 1 cm. longa quam sepalis longiore, hypocraterimorpha cum tubo lato: staminibus inaequaliter affixis; filamentis inaequilongis usque ad medium corollae adnatis, marginibus liberis edentatis; stylis capitatis; capsula oblonga acuminata.

Only a few specimens were collected. They are branches of an upright plant, densely hirsute with long white hairs and crowded with leaves so revolute as to appear cylindrical. The flowers from the dried specimens seem to have been of a violet-purple color. No mature fruit was obtained. Collected near Movano, Coahuila. No. 4563. Type, Herb. Univ. Calif., No. 144716.

***Coldenia Purpusii* sp. nov.**

Suffruticosa prostrata hispida, caulibus tenuibus, saepe ad nodos radicanibus: foliis anguste ovatis acuminatis, margine cum setis ciliatis: floribus violaceis ad apices ramorum congestis: calycis segmentis lineari-lanceolatis cum setis ciliatis: stylis superne bifidis: verisimiliter nuculis secedentibus.

The specimens consist of numerous fragments of a prostrate spreading plant that sometimes roots at the nodes. They have few violet-blue flowers and although very mature hardly any fruit. The species seems nearest *C. canescens*. Collected at Minas de San Rafael, San Luis Potosi. No. 4857. Type, Herb. Univ. Calif., No. 148453.

Scutellaria potosina sp. nov.

Puberula e radice lignosa multicaulis; caulibus simpliciusculis, ca. 1.5 dm. altis, foliosis; foliis ovatis obtusis, margine integris, 6 mm. longis, 4 mm. latis, breviter petiolatis, utrinque viridibus: floribus axillaribus fere sessilibus, violaceis. 8 mm. longis: seminibus grosse tuberculato-rugosis, atris.

The specimens are so mature that all the fruit has fallen and few flowers remain. Collected at Minas de San Rafael, San Luis Potosi. No. 4874. Type, Herb. Univ. Calif., No. 148366.

Salvia Purpusii sp. nov.

Fruticulus, ramis cinereis cum pilis brevibus hispidis partim glandulosus instructis, cortice denique deciduo ramos laeves relinquente: foliis late ovatis vel oblongo-ovatis obtusis, basi cordatis, margine crenatis, cum pilis brevibus glandulosus pubescentibus; nunc demum rugosis, 2-3 cm. longis, 1-2 cm. latis; petiolis ca. 5 mm. longis: racemis 3-6 cm. longis; verticillis 2-floris: bracteis deciduis late ovatis obtusis vel acutis pubescentibus; pedicellis 4 mm. longis; calyce late campanulato glanduloso, 1 cm. longo, labiis aequalibus, superiore 3-dentato, inferiore cum lobis acutis: corolla 18 mm. longa, violacea, tubo gradatim ampliato, galea pubescente labio inferiore brevior; stylo glabro.

Collected on Cerro de Zapatero, Coahuila. No. 4636. Type, Herb. Univ. Calif., No. 144749.

Salvia farinacea Benth. var. **heteranthera** var. nov.

Calyx corollaque minores pubescentiores; connectivis postice bipartitis.

This Texan species has not heretofore been credited to Mexico. The variety differs in having the calyx more tomentose and especially in having the posterior portion of the connective deeply lobed. But few specimens were collected, probably only for the fungus with which they are infested. Sierra de la Paila, Coahuila. No. 4754. Type, Herb. Univ. Calif., No. 148256.

Salvia parrasana sp. nov.

Perennis, caulibus ascendentibus ca. 2 dm. altis parce pilosis cum pilis glanduliferis: foliis inferioribus late ovatis obtusis,

basi in petiolum alatum cuneatis, crenatis, subtus paucis pilis curvatis, rubropunctatis, supra sparsim pilosis, foliis superioribus similibus majoribus ca. 3–4 cm. longis, petiolum alatum includentibus, 1.5–2 cm. latis; pedunculis 4–6 cm. longis: verticillis approximatis ca. 6-floris, pedicellis 1 cm. longis, bracteis ovatis acuminatis cum pilis longis ciliatis; calyce campanulato, 5 mm. longo, setuloso rubropunctato, labio superiore integro cum nervo excurrente mucronato, lobis labii inferioris acuminatis; corolla 1 cm. longa, violacea, tubo calyci aequali, labio inferiore quam galea duplo longiore, connectivis postice longitudinaliter connatis, supra dilatatis callosodentatisque, stylo supra densissime barbato.

Collected at high altitudes of Sierra de Parras, Coahuila. No. 4637. Type, Herb. Univ. Calif., No. 144748.

Hedeoma montana sp. nov.

Frutescens ramosa, 1.5–2 dm. alta; foliis pubescentibus ovatis acuminatis dentatis, ca. 8 mm. longis, basi in petiolum angustatis; verticillastris ad apices ramorum axillaribus; corollis violaceis, 12 mm. longis calyce pubescente duplo longioribus, fauce inflata; calycibus tubulosis striatis parum gibbosis, dentibus erectis lineari-lanceolatis consimilibus, ca. 2 mm. longis, sub fauce intus villosis; staminibus 2 exsertis, filamentis sterilibus nullis; antherarum loculis demum divaricatis.

Collected on Sierra de la Paila, Coahuila. No. 4964. Type, Herb. Univ. Calif., No. 150013.

Lithophytum gen. nov. **Solanacearum?**

Calyx campanulatus 5-lobatus. Corolla gamopetala 5-lobata. Stamina 5, tubo corollae affixa, lobis alternantia. Ovarium superum 1-loculare, ovula 2–4 saepissime 2, juxta basin parietalia. Stigma sessile. Fructus ignotus. Frutex ramosus, cortice fusco-cinereo. Folia ad nodos fasciculata crassa.

Lithophytum violaceum sp. nov.

Ramis longis diametro ca. 5 mm. glabris, internodiis 6–10 mm. longis; foliis ellipticis, 2.5 mm. longis, 4 mm. latis, margine integris minute ciliatis, basi cordatis, mucronatis, primum obtusis demum emarginatis, nervis contralibus et intramarginalibus

ad apices conjunctis: floribus ad nodos vel foliosos vel aphyllous pedicellatis, pedicellis 2 mm. longis: calyce 3-4 mm. longo, fere ad basim 5-lobato, lobis lanceolatis puberulis: corolla violacea 8 mm. longa, extus puberula, tubo cylindraco supra ampliato, lobis venosis patentibus inaequalibus, 2 superioribus brevioribus: staminibus saepe tubo inaequaliter adnatis, antheris dorso prope basim sagittatam affixis, loculis per totam longitudinem dehiscentibus: stigmate parvo bilobato; disco ovario aequilongo.

This anomalous plant has corollas that suggest *Verbenaceae*, but the five perfect stamens belong rather to *Solanaceae*. The 1-celled ovary is uncommon in both orders. It seems to be related somewhat to *Henoonia*. The lobes of the corolla are conspicuously pinnate-veined. The ovules, generally two, sometimes three and rarely four, are attached to the walls of the ovary near the base or slightly above it. Collected at Santa Lucia, Puebla, April, 1908, growing among rocks. No. 4450. Type, Herb. Univ. Calif., No. 143297.

***Stemodia Purpusii* sp. nov.**

Perennis multicaulis e radice lignosa 1-1.5 dm. alta, resinosa puberula: foliis oppositis sessilibus oblongis acuminatis acute serratis, inferioribus 5 mm. longis, 4 mm. latis, superioribus minoribus; floribus solitariis axillaribus, pedicellis foliis brevioribus; calyce 6-7 mm. longo quam bracteolis linearibus longiore, lobis lanceolatis inaequalibus; corollis caeruleis 10-12 mm. longis, tubo intus piloso gradatim ampliato; capsula calycem aequante demum valvis 4 dehiscente; antherarum loculis stipitatis.

Collected at Movano, Coahuila. No. 4456. Type, Herb. Univ. Calif., No. 143232.

***Pentstemon punctatus* sp. nov.**

Frutescens, caulibus juvenibus purpureis puberulis; foliis glabris oblongis spathulatisve, basi cuneatis, sessilibus, punctatis ca. 3 cm. longis, 1 cm. latis; panicula pauciflora; pedunculis pubescentibus; bracteis ovato-acuminatis puberulis; pedicellis 5-15 mm. longis; capsula ovato-acuminata quam sepalis duplo longiore; floribus violaceis 1.2 cm. longis; antherarum loculis demum explanatis, margine ciliatis.

The specimens are very mature and bear but few flowers. Collected on Sierra de la Paila, Coahuila. No. 4747. Type, Herb. Univ. Calif., No. 148291.

***Pinguicula gypsicola* sp. nov.**

Foliis exterioribus rosulatis oblongis obtusis fuscis puberulis carnosius, 4–7 mm. longis: interioribus lineari-lanceolatis, ciliatis cum pilis multiarticulatis, 4–6 cm. longis, basi 2–7 mm. latis: corollae caeruleae tubo, quam lobis multo brevior; lobis oblongo-spatulatis patentibus, ca. 6 mm. longis: calcar tenui, ca. 2 cm. longo: scapo 4–7 cm. longo.

A handsome species collected on wet gypsum rocks at Minas de San Rafael, San Luis Potosi. No. 4886. Type, Herb. Univ. Calif., No. 148373.

***Carlowrightia parvifolia* sp. nov.**

E radice lignosa multicaulis 1–2 dm. alta; caulibus ramosis retrorsum pubescentibus; foliis inferioribus oblongo-lanceolatis basi angustatis ca. 8 mm. longis, 2 mm. latis, foliis superioribus linearibus; pedicellis ex axillis foliorum superiorum, 5–10 mm. longis, prope apicem bracteatis; calyce 4–5-partito, segmentis retrorsum pubescentibus; corollae tubo 2 mm. longo, lobis 5 mm. longis, 2.5 mm. latis; antherarum loculis contiguus parallelis, loculo altero altius affixo; capsula 1 cm. longa, basi in stipitem solidum 5 mm. longum contracta; seminibus cordatis, uno latere rugosis altero scabridis.

Collected on Sierra de la Paila, Coahuila. No. 4751. Type, Herb. Univ. Calif., No. 148260.

***Lobelia Purpusii* sp. nov.**

Verisimiliter annua, glabra pusilla rupes humidus habitans: caulibus 8–13 cm. altis, tenuibus; foliis lineari-lanceolatis sessilibus, basi angustatis, ca. 2.3 cm. longis, 1 mm. latis, margine hirsutulis: racemis paucifloris aphyllis; pedicellis ca. 16 mm. longis; bracteis ca. 5 mm. longis linearibus; calycis tubo breviter obconico, laciniis linearibus quam tubo multo longioribus: corolla 1 cm. longa caerulea; antheris inferioribus barbatis: capsula fere globosa semilibera.

Growing in masses on wet rocks at Zacuapan, Vera Cruz. No. 4933. Type, Herb. Univ. Calif., No. 148806.

***Ericameria Purpusii* sp. nov.**

Fruticulus ramosus, foliolis lineari-lanceolatis acuminatis ca. 2 mm. longis in axillis foliorum 5-7 mm. longorum linearium acuminatorum decurrentium demum cinereorum spinescentium fasciculatis: capitulis ramos terminantibus 6-7 mm. altis fere sessilibus discoideis; involucri bracteis 4-5 seriatis ovato-lanceolatis acuminatis gradatim in folios mutantibus; corollis 8-10, luteolis in lobos ovato-lanceolatos inaequaliter sectis; stigmatibus apice appendicibus lanceolatis terminantibus; antheris liberis; pappi setis copiosis corollam aequantibus; achaeniis turbinatis 2.5 mm. longis dense sericeo-villosis.

This species is remarkable for its spinose leaves and peculiar corollas. One lobe of each flower separated to the tube is much longer than the others. Technically its rayless heads would place it in *Bigelovia* as elaborated by Dr. Gray, but its habit and appearance is that of an *Ericameria*. It would be abnormal in any described genus. Collected on Cerro de Macho, Coahuila. No. 4479. Type, Herb. Univ. Calif., No. 143238.

***Verbesina parrasana* sp. nov.**

Caulibus, basi lignosis, ramosis, scabris, 2-3 dm. altis, foliis inferioribus oppositis, superioribus alternis ovato-acuminatis usque 4 cm. longis, 3 cm. latis, grosse-serratis, trinervatis, basi in petiolum ca. 1.2 cm. longum anguste alatum cuneatis; capitulis ramos terminantibus; pedunculis 3-5 cm. longis; involucri squamis 2-seriatis, oblongo-lanceolatis, 1.2 cm. longis, 2 mm. latis, pubescentibus; floribus radii flavis fertilibus, disci floribus numerosis, tubo brevi, fauce gradatim ampliata; antheris fere atris; radii achaeniis obtuse triangulis glabris rugosis, apice rotundis, calvis, disci achaeniis compressis cuneatis late alatis hirsutis; pappi aristis 2, achaenium aequantibus.

The heads are 3.5 cm. in diameter. The ray akenes are triangular in cross-section and (rarely) bear an awn similar to those of the disk akenes. The disk akenes are flattened and have a rib on one or both faces. Sometimes they are 3-winged and

3-awned with two of the awns contiguous. Collected on Sierra de Parras, No. 4635, and on Sierra de la Paila, No. 4640, Coahuila. Type, Herb. Univ. Calif., No. 144747.

***Perymenium cornutum* sp. nov.**

Caules ultra 3 dm. alti stricti striati scabro-pubescentes herbacei purpurei foliosi; foliis ovato-lanceolatis margine serratis, ca. 5 cm. longis, 2 cm. latis, supra parce scabro-hirsutis, subtus pallidioribus scabro-pubescentibus; petiolis ca. 1 cm. longis hirsutis cum pilis patentibus: capitulis caules terminantibus, pedunculis 5-9 cm. longis; involucri squamis ovatis circiter biseriatis, exterioribus obtusis, interioribus acutis; floribus ca. 25, radii 1 cm. longis, flavis; paleis conduplicatis acuminatis; achaeniis disci obovatis crassiusculis atrobrunneis plus minusve bullato-rugosis compressis 3 mm. longis 2 mm. latis truncatis, angulis duobus in cornua breviter terminantibus; pappi aristis flavidulis inaequalibus usque 4 mm. longis.

The specimens do not have the root and are very mature. The color of the akenes is variable and often the horns are absent. The leaves near the tip are curved downwards and in the pressed specimens are often conduplicate. Collected at Agua Media, San Luis Potosi. No. 4767. Type, Herb. Univ. Calif., No. 148401.

***Pectis panamensis* sp. nov.**

Annua ramosissima glabra 1-2 dm. alta: foliis oblango-linearibus acutis margine integris, basi setis paucis instructis, glanduloso-punctatis, 1-4 cm. longis, 2 mm. latis: capitulis solitariis axillaribus, pedunculis 1-3 cm. longis; involucri squamis 8 acuminatis, 3-4 mm. longis, glandulis paucis linearibus, dorso costa elevata notatis; flosculis liguliferis ca. 8 luteolis, disci 8-10; pappi squamis paucis ovatis acuminatis laceratis .05 mm. longis, apice interdum aristatis; achaeniis ca. 2 mm. longis parce pubescentibus.

This species differs from the description of *P. swartziana* in having in place of obtuse pappus scales those that are acute, lacerate and sometimes aristate and the leaves have four rows of small glands instead of two. The lacerate pappus is much

like that of some species of *Hymenatherum*. Communicated by Señor Bolivar Jurado and collected in Panama, fifty miles south of the Canal Zone. Type, Herb. Univ. Calif., No. 143320.

***Cacalia calva* sp. nov.**

Caules herbacei e radicibus bulbosis 4-5 dm. alti pubescentes: petiolis foliorum radicalium ca. 2 dm. longis, tomentosis basi dense lanatis, laminis circumscriptione orbiculatis diametro 10-14 cm. palmato-multipartitis, segmentis trisectis, foliis paucis caulium multo brevioribus alternis; capitulis discoideis paniculato-cymosis, pedunculis 2-6 cm. longis 3-4-bracteolatis; involucri squamis ca. 12 lineari-lanceolatis 1-seriatis 8 mm. longis, ca. 1 mm. latis, apice lanatis; corollae tubo tenui cylindraceo 3-4 mm. longo, lobis 5 profunde partitis lanceolatis, ca. 4 mm. longis, patentibus; styli ramis hirtellis apice appendice brevissima mucroniformi; antheris basi auriculatis; acheniis calvis compressis obovatis, apice contractis basi cuneatis, glabris crasse costatis, ca. 1 cm. longis, 5 mm. latis, demum involucrium superantibus.

Plantae primum undique plus minus lanato-tomentosae denique glabriores.

This plant, curious on account of its large akenes, its cymose inflorescence and pinnatisect leaves, has the appearance of an Umbellifer. It seems to be a *Cacalia* allied to *C. cervariacifolia*, which is *Mesoneuris bipinnatifida* Gray. The only important difference from *Cacalia* is the lack of pappus, a character not worthy of generic recognition. Collected on Cerro del Gavilan, Puebla. No. 4113. Type, Herb. Univ. Calif., No. 148805.

***Psathyrotes Purpusii* sp. nov.**

Caulis e radice perenni 5-7 cm. altus albo-lanatus: foliis congestis orbicularibus diametro ca. 2 cm. subtus albo-lanatis supra viridioribus tomentosis, margine crenatis; petiolis ca. 1.2 cm. longis albo-tomentosis; capitibus 1-2 fere sessilibus 1.5 cm. altis: involucriorum squamis anguste oblongis obtusis tomentosis 1-2-seriatis: floribus ca. 25, pallidis vel purpureis: styli ramis lineari-subulatis.

This is a very distinct species. It is a small plant with lanate-tomentose stem and leaves. The style branches resemble those

of *Liabum*, but the involucre is not imbricated and the leaves are alternate. It has the narrow cylindric corollas with short hairy lobes of *Psathyrotes*, but the akenes and texture of the leaves are very different from the desert species of that genus. Perhaps it should be considered the type of a genus. Collected at foot of Sombrerito near Marte, Coahuila. No. 4763. Type, Herb. Univ. Calif., No. 148410.

***Perezia Purpusii* sp. nov.**

Caules ramive purpurei striati glabri vel puberuli; foliis glabris chartaceis oblongis acuminato-dentatis, apice acuminatis, basi auriculato-amplexicaulibus, ca. 6 cm. longis 3 cm. latis, utrinque viridibus reticulato-venosis: capitibus 1-4, caules terminantibus turbinatis, diametro 3 cm., floribus ca. 50 laete purpureis; involucri squamis lanceolatis acuminatis ca. 1.3 cm. longis, margine arachnoideo-lanatis, in bracteis gradatim transeuntibus; pedunculis 4-6 cm. longis bracteosis, bracteis in folios parvos transeuntibus.

The specimens have no roots and few of them are branched. The color of the flowers is similiar to that of purple flowered thistles. Collected at Minas de San Rafael, San Luis Potosi. No. 4787. Type, Herb. Univ. Calif., No. 148464.

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NEW AND NOTEWORTHY CALIFORNIAN
PLANTS, I

BY
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As a result of field and herbarium studies on Californian plants, the author has become convinced that many of the so-called "new species" proposed during the last two or three decades are untenable. It is often found that the new proposal either fits exactly into an earlier described species, which has been overlooked or misunderstood, or is connected with it by a series of intermediate forms, the variations being usually the result of adaptations to local environments. However, this naming of ecologic forms as species is not entirely without value, since attention is often thus called to variable characters which might otherwise be overlooked. Moreover, the systematist, who is more concerned with problems of genetics than he is with the naming of new forms, will ultimately be able, as the result of extended field observations and cultural experiments, to reduce these "species" properly to subordinate rank, indicating their relationship by the ordinary methods.

The present paper aims to classify properly a few of these recently described forms and indicate the factors which have probably brought them about. A few new forms are also described. This contribution is offered at the present time to provide for the technical publication of certain new names and combinations. It is desired to use these in a *Yosemite Flora*, now in preparation, but it is believed that most botanists will appreciate the advantage of having them first appear in a more generally accessible publication.

***Allium campanulatum* Wats.**Proc. Am. Acad., xiv, 231 (1879). *A. Bidwelliae* Wats., l.c.

Since only variable characters can be found to distinguish *A. Bidwelliae* from *A. campanulatum*, the two are better taken as one species under the latter name, which is to be retained because of priority of position on the page. *A. Bidwelliae* is of smaller size, with somewhat shorter pedicels and smaller flowers with narrower segments. But there is a gradation in every character. The bulb-coats are of two sorts on each bulb; the inner coats have sinuous reticulations, while the outer coats have rectangular reticulations. These have been well figured by M. E. Jones in his *Contributions to Western Botany*, no. 10, figures 24, 52 (1902). Both forms are common in loose, gravelly soil, from Mount Shasta south to Tulare County. Typical *A. campanulatum* ranges west to Buck Mountain, Humboldt County (*Tracy*, no. 2836), and an intermediate form has been collected as far east as Marlette Lake, western Nevada (*Baker*, no. 1391; *Hall & Chandler*, no. 4590). The typical, robust form is most common at altitudes of 900 to 1800 m.; the smaller (*Bidwelliae*) form, at 1500 to 2600 m., but the ranges overlap and the two sometimes come together, as near Sequoia, Yosemite Park, alt. 1828 m. (*Hall & Babcock*, nos. 3403, 3403a). In addition to collections already cited, the following may be taken as typical *A. campanulatum*:

Mount Bullion, Mariposa County., *Bolander*, no. 4943 (type collection); Big Trees, *Bolander*, Herb. Univ. Calif. no. 3076; Pine Ridge, Fresno County, *Hall & Chandler*, no. 227. As representing the extreme *Bidwelliae* form we may include: northeastern Shasta County, *Hall & Babcock*, no. 4145; vicinity of Lake Tahoe, July, 1901, *Setchell & Dobie*; Gilmore's, Tallac, July, 1895, *C. J. Fox, Jr.*; Jackson, Amador County, 1892, *Hansen*, Herb. Univ. Calif. no. 3065; Conness Creek, Tuolumne County, *Jepson*, no. 4490. The following are variously intermediate: near Morgan Springs, Mount Lassen, *Hall & Babcock*, no. 4328; Lake Lucile, vicinity of Tahoe, *Hall & Chandler*, no. 4667; Benson Lake, Tuolumne County, *Jepson*, no. 4518; Kaweah Basin, *Hopping*, no. 73; Salmon Creek, Tulare County, *Hall & Babcock*, no. 5136.

***Streptanthus tortuosus* var. *orbiculatus*, comb. nov.**

S. orbiculatus Greene, Fl. Fr., 258 (1891); Robinson, Synopt. Fl. N. Am., i, part 1, 472 (1897).

Studies of the sixty-five sheets of *S. tortuosus* and its forms now preserved in the Herbarium of the University of California, together with extensive observations in the field, clearly show that *S. orbiculatus* is a variant of *S. tortuosus*. It was described as differing especially in the habit, being lower and diffusely branched from the base. This seems in every case to be due to the early cessation of growth in the main stem, after which the lower branches elongate and curve upward, producing a low, bushy plant. Clear evidence of this is often present in the abortive central shaft, as in some specimens from Little Yosemite Valley (*Hall & Babcock*, no. 3447). The flowers of *S. orbiculatus* are described as smaller, but this is just what we would expect in a plant with an abnormally large number of branches and consequently with a large number of flowers. Plants gathered almost in the same handful exhibit the low habit with small flowers and the tall habit with large flowers, as in collections from 1340 m. alt. in northeastern Shasta County (*Hall & Babcock*, no. 4142). Finally, the "acute but not acuminate" sepals are too variable to be used as a distinguishing character. Specimens under State Survey, no. 1776 have the habit and small flowers of *S. orbiculatus*, but the acuminate and coiled sepals of *S. tortuosus*. The mature seeds are narrowly winged in both forms. All minor characters mentioned are as variable as those already pointed out.

As to distribution, both forms occur almost throughout the whole length of the Sierra Nevada, but the var. *orbiculatus* grows almost uniformly at higher altitudes and is most marked in specimens from near timber-line, where the flowers are commonly purple (Mount Tallac, July 1901, *Setchell & Dobie*; Pyramid Peak, 2985 m. alt., *Hall & Chandler*, no. 4719; Mount Lyell, 3351 m. alt., *Hall & Babcock*, no. 3586a; Mount Silliman, Aug., 1905, *Mrs. Katharine Brandegee*). Purple and yellowish-white flowers sometimes occur on near-by plants (Alta Meadows, Tulare County, Aug. 3, 1905, *Mrs. Katharine Brandegee*). At

altitudes of 1200 to 1800 m. the two forms come together and intergrade (*Hall & Chandler*, no. 357; *Hall & Babcock*, no. 4142). It therefore seems best to reduce *S. orbiculatus* to a geographic and ecologic variety of *S. tortuosus*, considering its characters as the result of habitat; the factors at high altitudes probably checking the elongation of the central axis, thus inducing the growth of many basal branches, which in turn produce many small flowers.

***Fragaria californica* var. *crinita*, comb. nov.**

F. crinita Rydb., Mem. Dept. Bot. Columbia Univ., ii, 171 (1898).

The characters used to separate this form from *F. californica* C. & S. are found to be inconstant, but it may best be recognized by the longer and whiter hairs of stems and petioles and by the thicker leaves, in this latter character approaching *F. chilensis* Duchesne, as pointed out by Dr. Rydberg. Large flowers were associated in the original description with a long and dense pubescence, but small flowers are frequently borne on long-hairy stems. This variety is confined to middle and lower altitudes of the Sierra Nevada, where it is the principal strawberry, and of the Coast Ranges in northwestern California. Good examples are Marble Mountain, Siskiyou County, *Chandler*, no. 1569; Brush Creek, Butte County, *Miss Kate Conger*; Mariposa Big Tree Grove, *Hall*, no. 8992; Redwood Meadows, Tulare County, *Hall & Babcock*, no. 5375.

***Fragaria virginiana* var. *platypetala*, comb. nov.**

F. platypetala Rydb., l.c., 177.

This western form is so similar to the eastern species that it is often impossible to distinguish them. In the field, however, it has a smoother and greener appearance, the leaves being somewhat glaucous. The petals are described as being larger and rounder, but specimens gathered in Wisconsin by Harley P. Chandler have petals as large as any I have seen in California plants. The variety is common in the Sierra Nevada from about 1200 to 2750 m. alt. In the Yosemite Valley and at Hog Ranch, near Hetch Hetchy Valley, are found large fields of what appear to be genuine *F. virginiana* introduced by the early

settlers. Blasdale's 1895 collection, cited by Rydberg under *F. platypetala*, came from one of the patches in Yosemite Valley.

***Fragaria virginiana* var. *platypetala* f. *sibbaldifolia*, comb. nov.**

F. sibbaldifolia Rydb., l.c. 176.

The characters of this form are plainly the result of its sub-alpine habitat. Fruiting specimens were examined on Olancha Mountain, Tulare County. The akenes were set in deep pits, as in *F. virginiana* and its var. *platypetala*, of which this is plainly a subalpine form, as its habit and foliage characters indicate. Although specimens from near timber-line seem quite distinct, intermediates are not rare (e.g., *Hall & Babcock*, no. 3549, from Tuolumne Meadows at 2620 m. alt.). This form is plentiful along the Upper Kern River at 2400 to 2700 m. alt. and probably ranges throughout the High Sierra Nevada, since it occurs on Mount Dana.

***Hosackia strigosa* var. *hirtella*, comb. nov.**

Lotus hirtellus Greene, Pitt., ii, 142 (1890).

The type of *L. hirtellus* came from "High ridges of the mountains north of Hetch Hetchy Valley in the Sierra Nevada, California," and Dr. Greene later reported it from the Mount Diablo Range.¹ It is plentiful in the drier parts of the pine belt around Yosemite Valley, extending thence southerly along the foothills to the western borders of the Mohave and Colorado deserts, appearing also on the coastal slope of southern California and there passing into the species. It is a xerophytic form of *H. strigosa*, which belongs mainly to the less arid coast districts, the type locality being "Dry gravelly hills near Monterey"; but the Monterey hills are by no means as dry as those inhabited by the variety in the Sierra Nevada and in southern California. Var. *hirtella* differs only in its more dense and spreading pubescence, especially on the stems, and in the usually more rounded and obtuse leaves. The leaf-shape, however, is variable in the species, as specimens distributed by Mr. A. A. Heller under nos. 6588, 6818, and 7375 will indicate. The

¹ Greene, *Fl. Fr.*, 19 (1891).

notching of the seeds is likewise not dependable. Neither in the species nor in the variety are the seeds plainly notched, except on one side, although they are often much wrinkled on the others. Beside the type collection, at least a portion of which I have examined, the following, selected from a large series, will indicate the distribution of var. *hirtella*:

Coulterville Road near Yosemite Valley, alt. 1218 m., and warm soil near foot of Yosemite Falls, *Hall*, nos. 8882, 8958; Bakersfield, Kern County, *J. Burtt-Davy*, no. 1791; Antelope Valley, Los Angeles County, *J. Burtt-Davy*, nos. 2500, 2530; Waterman Cañon, San Bernardino County, *Parish*, no. 5925 (intermediate); Coyote Cañon, Colorado Desert, *Hall*, nos. 1907, 2776; Warner's Ranch, San Diego County, April 30, 1894, *Brandege*.

***Sidalcea reptans* Greene**

Pitt., iii, 159 (1897).

S. favosa Congdon, Eryth., vii, 183 (1900).

Specimens of *S. favosa*, named by the author of that species and presumably of the type collection, agree exactly with those of the type collection of Greene's species. The late Judge Congdon, in proposing his species, evidently overlooked the description of *S. reptans*, as well as the fact that the stems creep and root at the base. Apparently the first collection of *S. reptans* was made by the botanists of the California State Geological Survey, at the Mariposa Grove of Big Trees in 1866, no. 4998.

***Sidalcea asprella* Greene**

Bull. Calif. Acad., i, 78 (1885).

Specimens of the type collection of *S. montana* Congdon, l.c., are referable to this species, differing only in the somewhat less densely pubescent foliage. Perhaps both of these will eventually be united with *S. glaucescens* Greene (l.c., 77), since they are now kept out only on characters of habit and pubescence, and these vary with ecologic conditions. The rugosity of the akenes has already been pointed out in the *Synoptical Flora* as unreliable. In all of these forms some plants bear only flowers which do not yield pollen. These imperfectly pistillate flowers are often not one-half the size of perfect flowers on neighboring plants.

***Sidalcea spicata* (Regel) Greene**

Bull. Calif. Acad. Sci., i, 76 (1885).

This includes both *S. ranunculacea* Greene and *S. interrupta* Greene, *Leaflets*, i, 75 (1904). The direction of the pubescence, cut of the leaves, and the size and arrangement of flowers in the spike are all much too variable—and non-concomitantly so—to make even fair varieties. This conclusion is the result of field studies made at type localities and of the examination of copious material from the Sierra Nevada. The type locality of *S. ranunculacea* is Hockett's (not "Hacket's") Meadow.

Kalmia polifolia* var. *microphylla*, comb. nov.K. glauca* γ *microphylla* Hook., Fl. Bor. Am., ii, 41 (1834).*K. microphylla* Heller, Bull. Torr. Bot. Club, xxv, 581 (1898).

The oldest name of the species is *K. polifolia* Wang. (1788), but the variety has not been hitherto transferred. It is common along the Sierra Nevada as far south as Mineral King, Tulare County, always growing near or above timber-line. These Sierran plants are all referable to the variety, which was first described from "Swamps in the Rocky Mountains." The Sierran specimens vary from plants only 7 cm. high, with leaves 7 to 10 mm. long (Mount Goddard) to plants 15 cm. high, with leaves 10 to 20 mm. long (Lucile Crest, near Lake Tahoe). The species itself should perhaps be accredited to California on the strength of two specimens collected on Trinity Summit, Humboldt County, in the North Coast Ranges (*J. Burt-Davy*, nos. 5823, 5861B). These are 22 cm. long and evidently represent only the tops of much longer stems; the leaves are 15 to 20 mm. long. No characters upon which the variety might be raised to specific rank have as yet been pointed out, except the variable one of size in plant and leaf.

DODECATHEON IN THE SIERRA NEVADA

The critical treatment given this genus by R. Knuth in *Das Pflanzenreich* is, on the whole, satisfactory; yet, because of the dearth of material from the Sierra Nevada, a few forms were overlooked. Moreover, one familiar with the wide variation in

these plants, as observed in the field, can hardly be expected to distinguish them on such characters as the size of the plant, or the number of flowers, the only characters given in the key for the separation of our two most common species. A synopsis of our forms is therefore given below.

Filaments distinct to the base.

Inflorescence glandular; style usually glandular toward the base.

Corolla closely reflexed, exposing the purple bases of the anthers.

Plant commonly 3 to 6 dm. high; leaves 15 to 30 cm. long.....1. *D. Jeffreyi*.

Plant 1 or 2 dm. high; leaves 1 to 4 cm. long 2. *D. Jeffreyi* f. *pygmaeum*.

Corolla not closely reflexed, enclosing the bases of the anthers.....3. *D. Jeffreyi* var. *redolens*.

Inflorescence and whole plant glabrous; style not glandular.

Leaves acutish, ligulate, 2 to 15 mm. broad.

Plant 15 to 40 cm. high; leaves 5 to 15 cm. long.....4. *D. alpinum*.

Plant 4 to 15 cm. high; leaves 1 to 4 cm. long.....5. *D. alpinum* f. *nanum*.

Leaves obtuse, oblong, 7 to 25 mm. broad.....6. *D. tetrandrum*.

Filaments united into an exerted tube; leaves broader in proportion.

Tube of filaments yellow, very short.....7. *D. conjugens*.

Tube of filaments deep purple, prominent.....8. *D. Hendersonii*.

1. *D. Jeffreyi* Van Houtte

Fl. des serres, xvi, 99 (1865-67).

Plant large in the typical form, commonly 3 to 6 dm. high; leaves 1.5 to 3 dm. long by 1.5 to 5 cm. broad; flowers mostly 4-merous; corolla closely reflexed, exposing a purple ring on its throat; style usually glandular toward base, sometimes without glands; capsule shorter than calyx-lobes or rarely a little longer.

This, the var. *typica* R. Knuth, is the most common form in the Sierra Nevada, growing in damp, especially meadowy, places from 1200 m. alt. nearly to timber-line. The leaves are nearly always entire, but in specimens from Hockett's Meadows, Tulare County (*Hall & Babcock*, no. 5619), they are shallowly but sharply toothed (and rigidly acute), while in others from Mineral King, Tulare County (*Hall & Babcock*, no. 5345), entire and toothed leaves occur on the same plant. The flowers are sometimes irregularly 3 to 5-merous, as well illustrated under *Hall & Babcock's* no. 3342, from Hog Ranch, Yosemite Park. In this collection one flower is 3-merous throughout; another, on the same plant, is 4-merous throughout, while a third, still of

the same plant, has a 4-merous calyx, a 5-merous corolla, and 5 stamens. In near-by plants, 3 per cent of the floral whorls were in 3's, 79 per cent in 4's, and 18 per cent in 5's. These figures are approximations from sixty counts and do not include two flowers which were double, the parts all being in 8's.

2. *D. Jeffreyi* f. *pygmaeum* form. nov.

Parvum, 1-2 dm. altum, supra glandulosum et viscidum; rhizomis erectis; foliis crassis, oblanceolatis, obtusiusculis, margine integris, 1-4 cm. longis, 5-10 mm. latis, basi angustatis, in petiolum alatum contractis; umbella 1-4 floris; calyce 4-partita, laciniis lanceolatis, acuminatis, 5 mm. longis, tubo duplo longioribus; corolla rubro-purpurea, lobis oblongis, 10-15 mm. longis, angustis reflexis, basi intusque annulum purpureum ostendentibus; staminibus distinctis, basi purpureis; stylo basi glandulosa.

Wet soil on Pyramid Peak, Eldorado County, California, at an altitude of 2740 m., August 1, 1903, *Hall & Chandler*, no. 4739 (type); above Heather Lake, in the same district, July, 1901, *Stechell & Dobie*; Snow Flat, Yosemite National Park, altitude 2650 m., *Hall & Babcock*, no. 3486; mountain near Little Kern River, Tulare County, at 3300 to 3600 m., *Purpus*, no. 5239, in part. This is exactly the reverse of var. *redolens* as to stature, being small in all its parts. It occurs well up toward timberline, in the Canadian and Hudsonian life-zones. Notwithstanding the fact that it sometimes grows in wet soil, it is evidently a xerophytic (or oxylophytic) or a starved form of the species. The soil is sometimes rich in humus and is thus an acid soil. At Snow Flat some of the plants were in dry, well-drained, sandy soil. Either of these conditions would account for the dwarfed habit. At this locality were also gathered intermediate forms (nos. 3485, 3488) and, on better soil, specimens of fairly typical *D. Jeffreyi*, with much thinner leaves 1.5 dm. long (no. 3484). The shape of the corolla-lobes is variable. In pubescence, the proposed variety resembles *D. viscidum* Piper, a species of the Cascade Mountains, but that is a much larger plant, with relatively longer calyx-lobes.

3. *D. Jeffreyi* var. *redolens* Hall

Bot. Gaz., xxxi, 392 (1901).

Plant large, like robust specimens of the species; herbage redolent; flowers mostly 5-merous; corolla not closely reflexed,

with yellow band at throat; lower part of stamens and capsule enclosed in the corolla-tube.

Abundant on wet slopes near timber-line and the most showy form. The odor of the herbage is scarcely different than is sometimes noticed in typical *D. Jeffreyi*, and the flowers are occasionally 4-merous, but the folding of the corolla well up on



D. Jeffreyi, Van Houtte



D. Jeffreyi var. *redolens* Hall

the tube, so as to enclose loosely the bases of the stamens, is the most constant mark of this variety. It is readily distinguished by the absence of the purple ring on throat of corolla. But even this is somewhat variable (as in *Hall & Babcock*, no. 5398), indicating the close relation to *D. Jeffreyi*. Aside from the type collection from Mount Goddard, Fresno County, we now have it from many localities in the Southern High Sierra Nevada (*Culbertson*, no. 4531, distr. C. F. Baker; *Hall & Babcock*, nos. 5336, 5344, 5347, 5356, 5543), and from as far south as San Jacinto Mountain (*Hall*, no. 2335). At Farewell Gap, Tulare County, it forms large patches at timber-line, altitude 3080 m., while below timber-line, at 2860 m., is found nearly typical *D. Jeffreyi*.

4. *D. alpinum* (Gray) Greene

Eryth., iii, 39 (1895).

Plant slender, 15 to 40 cm. high in the typical form; leaves ligulate, acutish, 5 to 15 cm. long, 5 to 15 mm. broad, very smooth; pedicels 1 to 5 cm. long; flowers 4-merous, 2 to 7 in the umbel; style glabrous; capsule exceeding the calyx at maturity.

In wet or boggy meadows and along lake borders throughout the whole length of the Sierra Nevada, ranging north to Oregon and south to Mount San Jacinto. In the typical form this species belongs to the Canadian and Hudsonian life-zones, ranging from 1800 m. alt. in Siskiyou County to timber-line, above which it is replaced by the next form. It is entirely distinct from *D. Jeffreyi* both in appearance and in technical characters, not intergrading with it even where forms of the two come together. The following collections, all from California except the first and the last, are cited from a large series of this species:

Wallowa Mountains, eastern Oregon, *Cusick*, no. 2316; Marble Mountain, Siskiyou County, California, *Chandler*, no. 1572; Mount Lassen, *Hall & Babcock*, no. 4301; Donner Lake, *Heller*, no. 6936; Rubicon Park, Tahoe, July, 1901, *Setchell & Dobie*; Pyramid Peak, Eldorado County, and Black Mountain, Fresno County, *Hall & Chandler*, nos. 4698, 620; near Mineral King, Tulare County, *Coville & Funston*, no. 1436 (a narrow-leaved form); Mount Pinos, Ventura County, *Hall*, no. 6520; San Bernardino Mountains, *Parish*, nos. 3337, 3726; San Jacinto Mountains, *Hall*, nos. 801, 2348; Douglas County, Nevada, *Baker*, no. 1145.

5. *D. alpinum* f. *nanum* form. nov.

Pusillum, 4–15 cm. altum; foliis 1–4 cm. longis, 2–5 mm. latis; umbella 1–3-flora; pedicellis 5–15 mm. longis; floribus tetrameris; corolla rubro-purpurea, lobis oblongis, 8–10 mm. longis; stylo glabro. Forma ad *D. alpinum* typicum proxima sed minor in altitudine et magnitudine foliorum.

Mount Dana, Mariposa County, California, at 3350 m. alt., July, 1902, *Hall & Babcock*, no. 3618 (type); Snow Flat, Mariposa County, *Hall & Babcock*, no. 3487 (intermediate); near Mineral King, Tulare County, July 28, 1892, *Brandege*; mountain near Little Kern River at 3300 to 3600 m. alt. *Purpus*, no. 5239, in part. This is a truly Alpine form, using Alpine as indicating the belt above timber-line, but it ranges down into the forest belt, where it soon merges into the species. Dr. Purpus' specimens were gathered with exceedingly dwarfed ones of *D. Jeffreyi* f. *pygmaeum*.

6. *D. tetrandrum* Greene

Eryth., iii, 40 (1895).

Plant 15 to 40 cm. high; leaves oblong, obtuse, 5 to 15 cm. long, 7 to 25 mm. broad; pedicles 2 to 6 cm. long, except in de-

pauperate specimens; flowers 4-merous, 2 to 7 in the umbel; style glabrous; capsule exceeding the calyx.

Northern California and Nevada to Washington. This species is very close to *D. alpinum*, but is stouter in all its parts, the leaves are relatively broader and obtuse, and the pedicels are mostly longer. It does not connect at all with *D. Jeffreyi*, from which it differs in habit, in the perfectly glabrous herbage and style, and by a difference in the manner in which the corolla is reflexed. The following are referable to this species:

Mount Paddo, Washington, *Suksdorf*, no. 988; Marlette Lake, Nevada, *Hall & Chandler*, no. 4591; Modoc County, California, *Mrs. C. C. Bruce*, no. 2303; Trinity County, California, *Hall*, no. 8608; Lassen Creek, California, *Mrs. R. M. Austin*, no. 148.

7. *D. conjugens* Greene, l. c.

Plant 10 to 20 cm. high; leaves obovoid and broadly elliptic, very obtuse, 3 to 7 cm. long including the distinct petiole (to 13 cm. long, according to Greene), 10 to 20 mm. broad; flowers 5-merous, 1 to 5 in the umbel; filaments united, exserted from corolla-tube but very short, yellow; style not glandular; capsule exceeding the calyx.

A species belonging to the northward continuation of the Great Basin, from northeastern California to Wyoming. The united, exserted filaments distinguish it from any of the above, and the leaves are much broader in proportion to their length. I have seen the following:

Eastern Oregon, *Cusick*, no. 1843; Goose Lake, near the boundary between Oregon and California, May, 1894, *Mrs. R. M. Austin*; Goose Lake Valley, Modoc County, California, April, 1894, *Mrs. R. M. Austin*, no. 43; Goose Lake Plains, *Mrs. R. M. Austin*, no. 2308; Mount Bidwell, California, *Mrs. M. H. Manning*, no. 85.

8. *D. Hendersonii* Gray

Bot. Gaz., xi, 233 (1886).

This is known from all other Sierran species by the conspicuously exserted and deep-purple tube of the united filaments. The var. *Hansenii* Greene, *Eryth.* iii, 71 (1895), is scarcely distinguishable. All of the characters, such as the glabrous herbage, entire leaves, short, spreading stamens, etc., also occur in Coast Range plants. Aside from Hansen's collection, I have seen only

two from the Sierra Nevada namely, Camino, Eldorado County, May, 1907, *Mrs. Katherine Brandegec*, and Pine Ridge, Fresno County, *Hall & Chandler*, no. 251. It is a low-altitude species. The statement in *Das Pflanzenreich* that the typical form occurs in the Sierra Nevada is an evident error, all of the stations mentioned being in the Coast districts.

***D. glastifolium* Greene**

Eryth., iii, 71 (1895).

The type specimens of this species were collected in the "Lava Beds of Modoc County, California, *Mrs. Austin*, 1894." I have seen nothing referable to this species and mention it here only because it may be found in the northern Sierra Nevada.

***Wyethia angustifolia* var. *foliosa* comb. nov.**

W. foliosa Congdon, Eryth., vii, 186 (1900).

This cannot be considered as more than the Sierra Nevada representative of the typical coast form. The characters are most marked in specimens from low altitudes and from Wawona, Yosemite, and other warm valleys. Such plants are tall, rough with somewhat appressed hairs, the heads small and with narrowly lanceolate acute bracts (Soquel Mills, Aug. 11, 1899, *Congdon*; Pine Ridge, Fresno County, *Hall & Chandler*, no. 92). At higher altitudes the heads are larger and the bracts longer. In the northern Sierra Nevada we find forms which approach the species, especially in the broader leaves and often foliaceous bracts (Fall River Springs, *Hall & Babcock*, no. 4182). In the north Coast Ranges of Humboldt County we again get good var. *foliosa*, but only in the very dry Hupa Valley (*Goddard*), and here, as well as southward in the same district, occur intermediate forms (Hupa Valley, *Burt-Davy & Blasdale*, no. 5726; Comptche, Mendocino County, *Miss H. A. Walker*, no. 313). The indications are that *W. foliosa* is a more strongly xerophytic form than *W. angustifolia*, due to its more arid habitat. It may therefore be accepted as an ecologic and geographic variety. The name *foliosa* was not well chosen, since the leaves are mostly narrower than in the species, although the taller stems naturally bear more of them.

Wyethia elata nom. nov.

W. ovata Gray, Proc. Am. Acad., vii, 357 (1867), Syn. Fl., i, pt. 2, 268 (1884), etc. Not *W. ovata* T. & G., Emory's Rept., 143 (1848); Abrams, Bull. Torr. Club, xxxii, 541 (1905).

As has been well pointed out by Professor Abrams, the specific name *ovata* must be restricted to the very different southern California species. It therefore becomes necessary to re-name this rare plant of the Sierra Nevada. The type specimens were collected by Bolander. Dr. Gray gives the type locality as "Clark's, Mariposa County." (*Proc. Am. Acad.*, loc. cit.). This station is now known as Wawona. The species has also been collected at Darrah, ten miles west of Wawona, by the late J. W. Congdon, and we now have it from the Pohono Trail, near Yosemite Valley, the collector unknown.



DIE HYDROPHYLLACEEN DER SIERRA NEVADA*

BY

AUGUST BRAND

1. HYDROPHYLLUM

1. **H. capitatum** Dougl. var. **b. alpinum** Wats. Bot. King. 249 (1871).—Nevada County: Truckee, *Bolander*. "High Sierras," *Lemmon*. Scheint selten zu sein auf der Sierra Nevada.

2. **H. occidentale** (Wats.) A. Gray in Proc. Amer. Acad., x. 314 (1875).—Sierra County, *Lemmon*. Amador County, 800 m., *Hansen*, no. 690. Kern County: Tehachapi Mountains, *Davidson*, no. 1738.

Var. **Watsonii** A. Gray *l. c.*—Nur im nördlichen Teil der Sierra Nevada. Shasta County: Burney Valley, *Baker & Nutting*. Sierra County: *Lemmon*; Webber Lake, *Kennedy & Doten*, no. 62. Nevada County: Independence Lake, 2300 m., *Hall & Babcock*, no. 4533a; Summit Camp, *Kellogg*.

2. NEMOPHILA

1. **N. aurita** Lindl. Bot. Reg., xix, t. 1601 (1833).—Tulare County: Brushy places, 900 to 1200 m., *Purpus*, no. 1298.

2. **N. maculata** Benth. ex Lindl. in Journ. Hortie. Soc., iii, 320 (1848).—Sehr verbreitet. Butte County: Forbestown, *E. Brooks* nach Chandler in Bot. Gaz., xxxiv, 200. Butte County?:

[* This paper is a preliminary contribution by Dr. A. Brand, who is preparing the Hydrophyllaceae for *Das Pflanzenreich*. It is based to a considerable extent upon specimens from the Herbarium of the University of California, these having been loaned to Dr. Brand for examination. However, not all of the University material was sent, and the specimens cited do not, therefore, indicate all of the available information in regard to distribution.—ED.]

"Ad rivulos in montibus Sacramento," *Hartweg*, no. 1867. Nevada County: Nevada City, *Tiling*; Penn Valley, *Jepson* nach Chandler *l. c.* Placer County: *Bolander*, nos. 4551 u. 4566 nach Chandler *l. c.* Eldorado County: Rose Springs, *M. H. Gatos* nach Chandler *l. c.* Amador County: New York Falls, 700 m., *Hansen*, no. 88; Panther Creek, 1600 m., *Hansen*, no. 1153 u. 1154. Calaveras County: Big Tree Grove, *Ball*. Mariposa County, *Hillebrand*. Tuolumne County: Im Tal des Stanislaus River, *Stübel*. Fresno County: Pine Ridge, *Hall & Chandler*, no. 167 nach Chandler *l. c.*; Kaweah River Basin, *Hopping*, no. 138 nach Chandler *l. c.* Tulare County: *Purpus*, nos. 1732, 3059 u. 5706 nach Chandler *l. c.*; Mineral King and Coburn Mills, *Brandegge* nach Chandler *l. c.*

Var. **concolor** Brand var. nov.—Corolla maculis destituta (ut in *N. Menziesii*), sed squamae corollae oblongae usque ad medium liberae (ut in *N. maculata*).—Butte County: Clear Creek, *Brown*, no. 252.—Haec varietas est forma intermedia inter *N. Menziesii* et *maculata*.—Specimen originarium in Herb. Univ. Calif.

3. **N. Menziesii** Hook. et Arn. Bot. Beechey's Voy., 152 (1833); subsp. **A. insignis** (Benth.) Brand comb. nov. (*N. insignis* Benth.).

Conspectus formarum

- | | |
|---|--------------------------------|
| A. Corolla 25–35 mm. in diametro | var. a. Brandegeei |
| B. Corolla 20–25 mm. in diametro | |
| (a) Caules procumbentes vel ascendentes, elongati | var. b. typica |
| (b) Caules brevissimi vel subnulli, erecti | subvar. β acaulis |

Var. a. **Brandegeei** (Eastwood) Brand. comb. nov.—*N. Brandegeei* Eastwood in Bull. Torr. Bot. Club, xxix, 471 (1902).—Tulare County: Kaweah, *Hopping*, no. 166; Head of San Joaquin Valley, *Davy*. Kern County: Girard Station in the Tehachapi Mountains on grassy slopes, *Heller*, no. 7710.

Var. b. **typica** Brand, nom. nov. (*N. insignis* Benth., sensu proprio).—Amador County: New York Falls, 700 m., *Hansen*, no. 87; Antelope, 1400 m., *Hansen*, no. 1677.

Subvar. β **acaulis** Brand subvar. nov.—Butte County: near Clear Creek, *Brown*, no. 145.—Specimen originarium, *Hartweg*, no. 1869, in Herb. DC.

4. **N. spatulata** Coville in Contrib. U. S. Nat. Herb., iv, 156 (1893).—Fresno County: Pine Ridge, 1800 m., *Hall & Chandler*, no. 104, no. 423; Bearskin Meadow, South Fork of Kings River, *Eastwood* nach *Chandler l. c.* 208. Tulare County: *Death Valley Expedition*, nos. 1522 u. 1671 nach *Chandler l. c.* Kern County: Tehachapi Mountains nach *Davidson* in *Muhlenbergia*, iv, 66 (1908).

5. **N. humilis** Eastwood in Bull. Torr. Bot. Club, xxviii, 150 (1901).—Placer County: Emigrant Gap, *Jones*, no. 2816; Summit, *Eastwood* nach *Chandler l. c.* 201; Deer Park Inn, *C. J. Fox, Jr.* nach *Chandler l. c.* Tuolumne County: Tioga Road and Hetch Hetchy Road, *Congdon* nach *Chandler l. c.* Mariposa County: Hogan Mountains, *Congdon*; Konitz's place, *Congdon* nach *Chandler*.

6. **N. sepulta** Parish in *Erythea*, vii, 93 (1899).—Plumas County: Meadow south of Red Clover Valley, *Heller*, no. 8734. Sierra County: *Lemmon*, no. 168. Amador County: Stony Creek, *Hansen*, no. 1522. Unter den von *Lemmon* gesammelten Exemplaren befinden sich solche, die an der einen Placenta 2, an der anderen 3 Ovula tragen. Dies sind demnach Übergangsformen zwischen *N. sepulta* und *N. pedunculata*.

Var. **densa** (Howell) Brand comb. nov.—*N. densa* Howell, Fl. N. W. America, 466 (1901).—Corolla calyce duplo fere longior, saepe reticulata vel maculata.—Butte County: Clear Creek, *Brown*, no. 173.

7. **N. parviflora** Dougl. ex Benth. in Trans. Linn. Soc., xvii, 275 (1834).—Plumas County: *Hall & Babcock*, no. 4421.

Var. **quercifolia** (Eastwood) *Chandler l. c.* 210.—Fresno County: Pine Ridge, *Hall & Chandler*, no. 250; Sequoia Mills, *Eastwood* nach *Chandler l. c.* Tulare County: Limekiln Creek, *Jepson*, no. 2798. Kern County: Kernville, *Brandegee* nach *Chandler l. c.*; Greenhorn Mountains, *Palmer*, no. 32, nach *Chandler l. c.*; San Emidio Cañon, *Dary*, no. 2070.

8. **N. exilis** Eastwood in Bull. Torr. Bot. Club, xxviii, 148 (1901); *Chandler l. c.*, ex parte minima.—Mariposa County: Yosemite National Park, Merced Grove of Big Trees, 1800 m., *Hall & Babcock*, no. 3417. Tuolumne County: Hog Ranch Road, *Congdon* nach *Eastwood l. c.*

9. **N. heterophylla** Fisch. et Mey.! Sert. Petropol., i, subt. 8 (1846).—*N. divaricata* Eastwood! l. c. 153.—*N. exilis* Chandler l. c., ex parte, non Eastwood.

Systema speciei

- A. Folia usque ad rachin partita var. **a. eu-heterophylla**
 (a) Folia simpliciter pinnatifida subvar. **a. divaricata**
 (b) Folia plerumque bipinnatisecta subvar. **β tenera**
 B. Folia incisa tantum vel subintegra; pedunculi folium aequantes
 var. **b. flaccida**

Subvar. **β tenera** (Eastwood) Brand comb. nov.—*N. tenera* Eastwood l. c. 153.—Placer County: Newcastle, *Bolander*, no. 4584. Amador County: Drytown, *Hansen*, no. 2064.

Var. **b. flaccida** (Eastwood) Brand comb. nov.—*N. flaccida* Eastwood l. c. 149.—Butte County: bei Clear Creek, *Brown*, no. 261.

10. **N. nemorensis** Eastwood l. c., 155.—*N. exilis* Chandler l. c., ex parte, non Eastwood.

Systema speciei

- A. Corolla 4–6 mm. longa
 (a) Corolla 6–12 mm. lata var. **a. typica**
 (b) Corolla 4–7 (raro-10) mm. lata var. **b. glauca**
 B. Corolla 2–3 mm. longa var. **c. gracilis**

Die typische Form nur an der Küste.

Var. **b. glauca** (Eastwood) Brand comb. nov.—*N. glauca* Eastwood, l. c., 156.—Form des Sacramento Tales. “In valle Sacramento.” *Hartweg*, no. 1868. Butte County: Berry Cañon, near Clear Creek, *Heller & Brown*, no. 5507. Sutter County: Marysville Buttes, *Heller*, no. 7562.

Var. **c. gracilis** (Eastwood) Brand comb. nov.—*N. gracilis* Eastwood l. c., 154.—Amador County: Drytown, *Hansen*, no. 542. Kern County: Girard Station, *Heller*, no. 7718.

11. **N. pulchella** Eastwood l. c., 157.—*N. exilis pulchella* Chandler l. c., 214.—Fresno County: Zwischen Dunlap und Millwood, *Jepson*, no. 2769. About rocks above Pollasky, *Heller*, no. 8151. Tulare County: Vicinity of Kaweah, *Hopping*, nos. 257, 295, 533; Frazers Mill, *T. S. Brandegee* (no. 107261 in Herb. Univ. Calif.); Salt Creek, *Eastwood* nach Chandler l. c.; Cramer, *Brandegee* nach Chandler l. c.; Bear Creek, *Purpus*, no. 1720 nach Chandler l. c. Kern County: Greenhorn Range, *Hall & Babcock*, no. 5027.

BEMERKUNGEN ÜBER NEMOPHILA HETEROPHYLLA
FISCH. ET MEY

In den beiden Monographien der Gattung *Nemophila*, die in den ersten Jahren des Jahrhunderts von Miss Eastwood und Mr. Chandler veröffentlicht wurden, sind Irrtümer in der Nomenclatur dadurch entstanden, dass den Verfassern die Originale der *N. heterophylla* nicht zugänglich waren. Zwar teilt Mr. Chandler mit, dass ihm Herr Geheimrat Fischer von Waldheim einen Zweig von dem Original übersendet habe; aber es muss da wohl irgend ein Versehen vorgekommen sein. Nur so ist es zu erklären, dass Mr. Chandler behauptet, *N. heterophylla* sei weiter nichts als eine Form von *N. Menziesii*. Ich, dem durch die lebenswürdige Vermittelung des Herrn Geheimrats Fischer von Waldheim die sämtlichen, sehr zahlreichen Exemplare der Originalsammlung vorgelegen haben, kann nun mit Bestimmtheit versichern, dass *N. heterophylla* mit *N. Menziesii* nichts zu tun hat, dass vielmehr *N. heterophylla* dieselbe Pflanze ist, die von Miss Eastwood unter dem Namen *N. divaricata* beschrieben wurde, und von Mr. Chandler mit unter *N. exilis* einbegriffen wurde. Die Bezeichnung "*N. exilis* Chandler" muss also in "*N. heterophylla* Fisch. et Mey." geändert werden. Ich halte im Gegensatz zu Mr. Chandler den Namen "*N. exilis* Eastwood" aufrecht und betrachte auch *N. nemorensis* Eastwood als besondere Art. Massgebend ist für mich dabei der Umstand, dass diese drei Arten nicht überall durcheinander wachsen. *N. heterophylla* (im engeren Sinne) ist die alleinige Form der Mendocino County, während andererseits in der Santa Clara County nur *N. nemorensis* vorkommt. *N. exilis* Eastwood (im engeren Sinne) dagegen wächst nur auf der Sierra Nevada, und scheint eine seltene Form zu sein. Dass Übergänge zwischen diesen Arten vorkommen, lässt sich allerdings nicht leugnen; aber wenn wir alle Arten einziehen wollten, zwischen denen Übergänge beobachtet werden, dann müssten wir z. B. auch *N. sepulta* als Synonym zu *N. pedunculata* setzen; ja nicht einmal *N. maculata* dürfte dann noch als selbständige Art betrachtet werden neben *N. Menziesii*.

3. **DRAPERIA**

D. systyla Torr. ex. A. Gray in Proc. Amer. Acad., vii, 401 (1868).—Weit verbreitet auf der Sierra Nevada. Siskiyou County: near Shasta Springs, *Heller*, no. 7966. Sierra County: *Lemmon*, no. 175. Placer County: Emigrant Gap, *Jones*, no. 2815. Fresno County: Pine Ridge, 1700 m., *Hall & Chandler*, no. 103; Sequoia Mills, *T. S. Brandegee*. Tulare County: Old Colony Mill, *K. Brandegee* (no. 126024 in Herb. Univ. Calif.). Nevada: Mt. Moses, 2700 m., *Purpus*, no. 1458. "Silver Mountains," *Hillebrand*.

Var. **minor** Brand var. nov.—Folia multo minora quam in forma typica, 5–8 mm. lata (in typo 10–25 mm. lata) omnia fere basi cuneata (in typo plerumque rotundata).—Mariposa County: Yosemite Valley, *Stübel*, Herb. Berlin. Specimen originarium (Coffee Creek, Trinity County, 1200 m. alt., *H. M. Hall*, no. 8545) in Herb. Univ. Calif.

4. **PHACELIA**

A. SECTIO EUPHACELIA

1. **Ph. platyloba** A. Gray in Proc. Amer. Acad., xvii, 223 (1882).—"Montes," *Bridges*, no. 183. An der Grenze der Madera und Mariposa counties: Merced Foothills, *Buckminster*. Mariposa County: *Congdon*, nos. 107299 u. 107307 in Herb. Univ. Calif.

2. **Ph. hispida** A. Gray, Syn. Fl., ii, 1, 161 (1878).

Conspectus formarum

A. Corolla calyceem distincte superans

(a) Foliola profunde incisa, quasi pinnatifida var. *a. genuina*

(b) Foliola minus incisa, crenata magis quam pinnatifida

a. Lobi foliolorum acuti subvar. *β cicutaria*

β. Lobi foliolorum obtusi subvar. *γ heterosepala*

B. Corolla calyceem aequans var. *b. brachyantha*

Var. *a. genuina* Brand var. nov.—Amador County: Clinton, 700 m., *Hansen*, no. 1650; New York Falls, 700 m., *Hansen*,

no. 151; Mokelumne River, *Hansen*, no. 1147. Inyo County: Bishop Creek, 1700 m., *Hall & Chandler*, no. 7268.

Subvar. β **cicutaria** (Greene?) Brand comb. nov.—*Ph. cicutaria* (Greene? in *Pittonia* v, 20 (1902).—Amador County: Drytown, *Hansen*, no. 266 u. 1266.

Subvar. γ **heterosepala** (Greene) Brand comb. nov.—*Ph. heterosepala* Greene l. c., 21.—Butte County: Iron Cañon above Chico, *Austin* (no. 107479 in Herb. Univ. Calif., type). Von subvar. β kaum zu unterscheiden.

Var. **brachyantha** Coville in *Contrib. U. S. Nat. Herb.*, iv, 158 (1893).—Fresno County: Tehipite Valley, 1300 m., *Hall & Chandler*, no. 481.

3. **Ph. ciliata** Benth. in *Trans. Linn. Soc.*, xvii, 280 (1834).—Kern County: Tehachapi, *K. Brandegee* (no. 126031 in Herb. Univ. Calif.).

4. **Ph. thermalis** Greene in *Erythea*, iii, 66 (1895).—Shasta County: Mesas south of Fall River Mills, at base of Bald Mountains, 1200 m., *Hall & Babcock*, no. 4269.

5. **Ph. ramosissima** Dougl. ex Benth. in *Trans. Linn. Soc.*, xvii, 280 (1834).—Auf der Sierra Nevada nur in der Form **decumbens** (Greene) Brand comb. nov. = *Ph. decumbens* et *Ph. fastigiata* Greene in *Pittonia*, v, 17 et 18 (1902) = *Ph. cremophila* (Greene l. c., 20.—Weit verbreitet. Lassen County: Honey Lake, *T. S. Brandegee* (no. 107339 in Herb. Univ. Calif.); "Grasshofer," *Austin*, no. 1363. Sierra County: *Lehman*, no. 171. Nevada County: Donner Pass, *Heller*, no. 7032. Ormsby County (Nevada): Eagle Valley, 1446 m., *Baker*, no. 1091; Kings Cañon, 1700–2000 m., *Baker*, no. 1198, von Greene als *Ph. cremophila* bestimmt. Washoe County (Nevada): near Marlette Peak, 2500 m., *Hall & Chandler*, no. 4570. Calaveras County: Bear Valley, 2000 m., *Hansen*, no. 268. Fresno County: Collins Meadow, 2500 m., *Hall & Chandler*, no. 542. Tulare County: Long Meadow, 2700–3000 m., *Palmer*, no. 205, Original zu *Ph. fastigiata* Greene; vicinity of Mineral King, 2600 m., *Hall & Babcock*, no. 5666.

6. **Ph. tanacetifolia** Benth. in *Trans. Linn. Soc.*, xvii, 280 (1834).

Conspectus formarum

- A. *Caulis solitarius elatus*
 (a) *Foliorum segmenta grosse et irregulariter incisa; stamina corollo duplo fere longiora* var. a. *genuina*
 (b) *Foliorum segmenta tenuiter et regulariter dissecta; stamina corolla vix longiora* f. *staminea*
 B. *Caules complures humiles. Stamina corolla vix longiora. Planta cinereo-incana. Corolla 4-5 mm. tantum (in typo 7-8 mm.) longa* var. b. *cinerea*

Die typische Form fehlt auf der Sierra.

f. **staminea** Brand form. nov.—Tulare County: Deer Creek; Felder, *Purpus* (no. 5687 in Herb. Univ. Calif.).

Var. **cinerea** Brand var. nov.—Inyo County: Argus Mountains, 1300-1600 m., *Purpus* (no. 5042 in Herb. Univ. Calif.).—An species propria?

7. **Ph. distans** Benth. Bot. Voy. Sulphur, 36 (1844).

Conspectus formarum

- A. *Foliorum segmenta pinnatifida*
 (a) *Sepala lanceolato-oblonga vel obovata* var. a. *eu-distans*
 (b) *Sepala linearia vel lineari-lanceolata* subvar. β *ammophila*
 B. *Foliorum segmenta crenata tantum nec pinnatifida; sepala linearia vel lineari-lanceolata* var. b. *australis*

Die typische Form (*eu-distans*) kommt auf der Sierra nicht vor.

Subvar. β **ammophila** (Greene) Brand subvar. nov.—*Ph. ammophila* Greene in Baker, *West American Plants*, ii, 15 (1903), no. 2806.—Tulare County: among rocks, 700-1000 m., *Purpus*, no. 1738 u. 1746. Kern County: Girard Station, 1000 m., Heller, no. 7709; Kernville, *Purpus*, no. 5702; Mt. Breckenridge, 2300 m., Grinnell, no. 135. Inyo County: Lone Pine, T. S. Brandegee (no. 107561 in Herb. Univ. Calif.).

Var. **australis** Brand var. nov.—Kern County: Greenhorn Range, 1500 m., Hall & Babcock, no. 5071 (in Herb. Univ. Calif.).

8. **Ph. Rattanii** A. Gray, *Syn. Fl.*, ii, 1, Suppl. 413 (1886).—Shasta County: Burney Falls, M. S. Baker, no. 397.

9. **Ph. magellanica** (Lam.) Coville in *Contrib. U. S. Nat. Herb.*, iv, 159 (1893).

Conspectus formarum

- A. Filamenta nuda (raro pilis paucissimis adspersa)
 subspec. I. *cu-magellanica*
- B. Filamenta omnia vel pleraque barbata
 subspec. II. *barbata*
- (a) Planta humilis caespitosa
 f. 1. *compacta*
- (b) Planta elatior, haud caespitosa
- a. Folia omnia paucissimis exceptis integerrima
- I. Caules humiles, 10–20 cm. alti; radix perennis
1. Folia argenteo-micantia
 f. 2. *alpina*
2. Folia griseo hirsuta
 f. 3. *frigida*
- II. Caules elati; radix saepe biennis
 f. 4. *griseophylla*
- β. Folia omnia vel partim partita
- I. Folia partim integerrima, partim auriculata, neque tamen
 pinnatifida
1. Folia 4-nervia
 f. 5. *egena*
2. Folia 8-nervia
 f. 6. *heterophylla*
- II. Folia inferiora pinnatifida
1. Folia radicalia longe petiolata
- Foliorum segmenta breviter acuta
 f. 7. *californica*
- Foliorum segmenta longe acuminata; planta plerumque
 nereo hirsuta
 f. 8. *bernardina*
2. Folia radicalia breviter petiolata
- Cyma breves distantes racemum vel corymbum laxum
 formantes
 f. 9. *patula*
- Cyma elongati erecti thyrsium longissimum densum for-
 mantes
 f. 10. *virgata*

Die typische Form (subspec. *cu-magellanica*) fehlt in Nordamerika. In Nordamerika wächst nur die Subspec. II *barbata*, von der die oben angeführten Formen auf der Sierra vorkommen. Die einzelnen Formen von *Ph. magellanica* sind nur zum Teil geographisch geschieden und gehen oft so in einander über, dass man sie mit Sicherheit nicht unterscheiden kann.

f. 1. **compacta** (Greene) Brand comb. nov.—*Ph. compacta* Greene in Baker, West American Plants, 18, no. 1142 (1902).—Siskiyou County: Mt. Shasta, Ash Creek, 1600 m., Hall & Babcock, no. 4111; nicht ganz typisch, nähert sich der Form 3. Eldorado County: Rubicon Park at Lake Tahoe, 2000–3000 m., Setchell & Dobie (no. 35538 in Herb. Univ. Calif.). Douglas County (Nevada): Spooner, 2155 m., Baker, no. 1142.

f. 2. **alpina** (Rydberg) Brand comb. nov.—*Ph. alpina* Rydberg, Fl. Montana, 324 (1900).—*Ph. circinnata* var. a. Parish in Zoë, v, 10 (1900).—*Ph. heterophylla* var. *alpina* Coulter

et Nelson, New Man., 408 (1909).—Sierra County: Sierra Valley, Lemmon in Herb. Boissier.

f. 3. **frigida** (Greene) Brand comb. nov.—*Ph. frigida* Greene in Pittonia, iv, 39 (1899).—Sehr verbreitet auf der Sierra.—Siskiyou County: Mt. Shasta, sunny rocks, 2700–3000 m., *Grant*, no. 5126. Ebendort, *Baker*, no. 3920 (nicht ganz typisch, nähert sich der Form 6). Trinity County: Mt. Eddy, *Baker*, no. 3831. Placer County: Soda Springs, 2000 m., *T. R. Perkins*. Mono County: Mt. Lyell, 3500 m., *Hall & Babcock*, no. 3568. Tuolumne County: Mt. Whitney, 4200 m., *Hall & Babcock*, no. 5536. Tulare County?: Soda Creek, 2700–3000 m., open woods, *Purpus*, no. 5664. Kern County: Tehachapi Mountains, 2200 m., *Abrams & MacGregor*, no. 433.

f. 4. **griseophylla** Brand form. nov.—Siskiyou County: Sisson, *K. Brandegee* (no. 107348 in Herb. Univ. Calif.). Plumas County: Red Clover Valley, *Heller*, no. 8755; nicht ganz typisch. Tulare County: Alta Meadows, *K. Brandegee* (no. 126045 in Herb. Univ. Calif.).

f. 5. **egena** Brand form. nov.—*Ph. egna* Greene ined.—*Ph. circinnata* var. b. Parish in Zoë, v, 11 (1900).—Tulare County: Kaweah River, *Baker*, no. 4415.

f. 6. **heterophylla** (Pursh) Brand comb. nov.—*Ph. heterophylla* Pursh, Fl. Amer. sept., i, 140 (1814).—Siskiyou County: along the railroad at Gazelle, *Heller*, no. 8080. Modoc County: Big Valley Mountains, *Baker & Nutting*. Placer County: Emigrant Gap, *Jones*, no. 2813. Donner, *K. Brandegee* (no. 107357 in Herb. Univ. Calif.). Fresno County: 1400 m., *Hall & Chandler*, no. 144.

f. 7. **californica** (Cham.) Brand comb. nov.—*Ph. californica* Cham. in Linnaea, iv, 494 (1829).—Von dieser Form, die sonst nur an der Küste vorkommt, befinden sich im Herb. Berlin zwei von Stübel gesammelte Exemplare, die die Zezeichnung tragen "Yosemite Valley" und "Mt. Davidson."

f. 8. **bernardina** (Greene) Brand comb. nov.—*Ph. virgata* var. *bernardina* Greene in Erythea, iv, 55 (1896).—*Ph. circinnata* var. c. Parish in Zoë, v, 11 (1900).—Siskiyou County: Yreka, *Heller*, no. 7993. Placer County: on dry hills at Newcastle, *Brewer*, no. 4580. Amador County: Stony Creek, 300 m.,

Hansen, no. 1614; White Bar, *Hansen*, no. 2057. Calaveras County: Sheep Ranch, *T. S. Brandegee* (no. 107580 in Herb. Univ. Calif.). Tulare County: Olancha Mountain, 2700 m., *Hall & Babcock*, no. 5291.

f. 9. **patula** Brand form. nov.—*Ph. circinnata* var. d. Parish in Zoë, v. 11 (1900).—"In valle Sacramento," *Hartweg*, no. 1865. Tehama County: Near Morgan, 1700 m., *Hall & Babcock*, no. 4385. Placer County: Newcastle, *Bolander*, no. 4580. Amador County: Wiley's Station, *K. Brandegee* (no. 107569 in Herb. Univ. Calif.). Calaveras County: Table Hills, *Davy*, no. 1603. Mariposa County: Hazel Green, *Jepson*. Fresno County: Dinkey Creek, 2000 m., *Hall & Chandler*, no. 363.—Specimen originarium, *Parish*, no. 4423 in herbario meo.

f. 10. **virgata** (Greene) Brand comb. nov.—*Ph. virgata* Greene in Erythea, iv, 54 (1896).—Shasta County: lava beds, 1300 m., *Hall & Babcock*, no. 4233. Plumas County: Genessee, *Heller*, no. 8852. Nevada County: lower end of Donner Lake, *Heller*, no. 6883. Boca, *K. Brandegee* (no. 107566 in Herb. Univ. Calif.). Ormsby County (Nevada): Kings Cañon, 1700–2000 m., *Baker*, no. 1040. Tulare County: Kaweah River, *Baker*, no. 4200. Placer County: on dry hills at Newcastle, *Brewer*, no. 4580. Amador County: Stony Creek, 300 m., *Hansen*, no. 1614; White Bar, *Hansen*, no. 2057. Calaveras County: Sheep Ranch, *T. S. Brandegee* (no. 107580 in Herb. Univ. Calif.). Tulare County: Olancha Mountain, 2700 m., *Hall & Babcock*, no. 5291.

10. **Ph. nemoralis** Greene in Pittonia, i, 141 (1887).—*Ph. mutabilis* Greene in Erythea, iv, 55 (1896).—Butte County: Colby, *Bruce*, no. 278. Amador County: Pedlar, *Hansen*, no. 1986. Calaveras County: Big Trees, *T. S. Brandegee* (no. 107350 in Herb. Univ. Calif.; Form mit gefiederten Blättern).

Var. **pseudohispida** Brand var. nov.—Flores distincte pedicellati, laxiusculi. Sepala elongata, anguste linearia. Capsula calyce 4-plo brevior.—Calyx fructifer ut in *Ph. hispida*, cetera ut in *Ph. nemoralis*.—An *Ph. nemoralis hispida*?—Shasta County: Stalkers, *M. S. Baker*, no. 344 (in Herb. Univ. Calif.).

11. **Ph. imbricata** Greene in Erythea, i, 127 (1893).

Conspectus formarum

- A. *Circinni fructiferi* 6–10 cm. longi
 (a) *Petoli foliis subaequilongis* var. a. *condensata*
 (b) *Petoli foliorum radicalium multo longiores quam folio oblongo-lanceolata integerrima* subvar. *Hansenii*
 B. *Circinni fructiferi* 10–16 cm. longi var. b. *caudata*

Var. a. **condensata** Brand. var. nov.—Amador County: New York Falls, 700 m., *Hansen*, no. 1283 in Herb. Berlin. Mariposa County: Yosemite Valley, *Bolander*, Herb. Boissier.

Subvar. **Hansenii** Brand subvar. nov.—Amador County: Irishtown, 500 m., *Hansen*, no. 1283 in Herb. Boissier, nicht in Herb. Berlin; siehe oben.

Var. b. **caudata** Brand var. nov.—Eldorado County: *K. Brandegee* (no. 130944 in Herb. Univ. Calif.).

12. **Ph. irritans** Brand Beiträge 7 (1911).—Lassen County: Pine Creek, *Baker & Nutting*. Plumas County: Big Meadows, *Austin* (no. 131530 in Herb. Univ. Calif.). Sierra County: Little Truckee River, 2100 m., *Hall & Babcock*, no. 4523.

13. **Ph. humilis** Torr. & Gray in Explor. Mississippi River, ii, 122 (1855).—Sehr verbreitet. Lassen County: Susanville, *T. S. Brandegee* (no. 133087 in Herb. Univ. Calif.). Plumas County: Red Clover Valley, *Heller*, no. 8783. Sierra County: Webber Lake, *Lemmon*, no. 170. Nevada County: lower end of Donner Lake, *Heller*, no. 6866; Truckee, *Miss Mitchener*. Placer County: Emigrant Gap, *Jones*, no. 3294; Lake Tahoe, *Ball*. Ormsby County (Nevada): Kings Cañon, 1700–2000 m., *Baker*, no. 921. Amador County: Armstrongs Station, 1700 m., *Hansen*, no. 1131. Mariposa County: Yosemite, *Yates*; Yosemite National Park, El Capitan, 2500 m., *Hall*, no. 9201; Yosemite Valley, *K. Brandegee* (no. 126000 in Herb. Univ. Calif.); head of Yosemite Falls, *Eastwood* (no. 131728 in Herb. Univ. Calif.). Madera County: Merced Mountains, *Heaton*. Fresno County: Pine Ridge, 1700 m., *Hall & Chandler*, no. 101; 1800 m., *Hall & Chandler*, no. 113. Tulare County: Mineral King, *T. S. Brandegee* (no. 131528 in Herb. Univ. Calif.). Pahute Mountains, 2300–2700 m., *Purpus*, no. 5303. Kern County: Tehachapi Mountains, nach Davidson in *Muhlenbergia*, iv, 67 (1908).

Var. **calycosa** A. Gray in Proc. Amer. Acad., x, 318 (1875).—Shasta County: Stalkers, *M. S. Baker*, no. 333 (in Herb. Univ. Calif.). Butte County, *Austin*, no. 1141. Mariposa County: Bear Valley, *Bolander*. Tulare County: Old Colony Mill u. Marble Fork, *Jepson*, no. 661.

14. **Ph. Eisenii** T. S. Brandegee in Zoë, ii, 252 (1891).—Fresno County: region of Dinkey Creek, 2000 m., *Hall & Chandler*, no. 362; Bald Mountains, 2800 m., *Hall & Chandler*, no. 378. Tulare County: Portersville, *T. S. Brandegee* (no. 124970 in Herb. Univ. Calif.). Middle Tule River, 2300–2700 m., *Purpus*, no. 1791. Mineral King, *T. S. Brandegee* (no. 131528 in Herb. Univ. Calif., ex parte). Alta Meadows, *K. Brandegee* (no. 126028 in Herb. Univ. Calif.).

15. **Ph. racemosa** (Kellogg) T. S. Brandegee in Zoë, ii, 252 (1891).—*Ph. namatoides* Gray.—Tehama County: Mt. Lassen, 2300 m., *Hall & Babcock*, no. 4324. Nevada County: Soda Springs, 2300 m., *Jones*, no. 2447; Donner Pass, *Heller*, no. 6981. Placer County: near Cisco, *K. Brandegee* (no. 112857 in Herb. Univ. Calif.); Van Norden Lake, *K. Brandegee* (no. 112858 in Herb. Univ. Calif.). Amador County: 1700 m., *Hansen*, no. 1137; 1800 m., *Hansen*, no. 1943. Fresno County: Dinkey Creek, 1800 m., *Hall & Chandler*, no. 335; 2500 m., *Hall & Chandler*, no. 435.

B. SECTIO EUTOCA

16. **Ph. linearis** (Pursh) Holzinger in Contrib. U. S. Nat. Herb., iii, 242 (1895).—Siskiyou County: Mt. Shasta, 1000 m., *Hall & Babcock*, no. 4087; 1500 m., *Hall & Babcock*, no. 4272. Igerna, along sandy banks, *Heller*, no. 8089. Lassen County?: Willow Creek Valley, *Austin*. Sierra County: *Lehman*, no. 172. Alpine County: Twin Lakes, 2800 m., *Hansen*, no. 270.

17. **Ph. procera** A. Gray in Proc. Amer. Acad., x, 323 (1875).—Lassen County: Susanville, *T. S. Brandegee* (no. 107396 in Herb. Univ. Calif.). Tehama County: at Morgan Spring, 1700 m., *Hall & Babcock*, no. 4395. Nevada County: *Carpenter*. Placer County: Emigrant Gap, *Jones*, no. 3403. Mariposa County?: Bear Valley, 1300 m., *Bolander*.

18. **Ph. hydrophylloides** Torr. ex A. Gray in Proc., l. c.—“Silver Mountains,” *Hillebrand*. Nevada County: Soda

Springs, 2300 m., *Jones*, no. 2416; near Frog Lake at the foot of Castle Peak, *Heller*, no. 7071. Mariposa County?: *Bolander*, nos. 4893 u. 4928. Fresno County: region of Dinkey Creek, 2500 m., *Hall & Chandler*, no. 416. Tulare County: Hocketts Meadow, *Baker*, no. 4456; Alta Meadows, *K. Brandegee* (no. 126030 in Herb. Univ. Calif.).

19. **Ph. curvipes** Torr. ex Wats. Bot. King, 252 (1871).

Conspectus formarum

A. Planta haud vel vix glandulosa

(a) Corolla calyce vix longior var. a. *eu-curvipes*

(b) Corolla calyce duplo fere longior var. b. *pratensis*

B. Planta superne dense glandulosa var. c. *yosemitana*

Var. a. **eu-curvipes** Brand. var. nov.—Inyo County: Pine Creek, *Hall & Chandler*, no. 7200; Independence Creek, 1800 m., *Hall & Chandler*, no. 7301; Sierra foothills south of Bishop, *Heller*, no. 8228.

Var. b. **pratensis** (Heller) Brand comb. nov.—*Ph. pratensis* Heller in *Muhlenbergia*, ii, 236 (1906).—Virginia City, Nevada, *T. S. Brandegee* (no. 107443 in Herb. Univ. Calif.). Inyo County: foothills west of Bishop, *Heller*, no. 8273. Kern County: Greenhorn Range, 1600 m., *Hall & Babcock*, no. 5035; Greenhorn Pass, desert region, shady places, 1300–1700 m., *Purpus*, no. 5698.

Var. c. **yosemitana** Brand var. nov.—Mariposa County: Yosemite National Park, Tenaya Trail above Mirror Lake, 1800 m., *H. M. Hall*, no. 8951 (type in Herb. Univ. Calif.).

20. **Ph. Pringlei** A. Gray in Proc. Amer. Acad., xvii, 223 (1882).—Siskiyou County: mountains about the headwaters of the Sacramento River, 2300 m., *Pringle*, 1, Sept., 1882; near Mt. Shasta, *Lemmon*. Lassen County: Eagle Lake, *Austin* (no. 107462 in Herb. Univ. Calif.).

21. **Ph. Purpusii** T. S. Brandegee in Bot. Gaz., xxvii, 451 (1899).—Mariposa County: Sherlock, *Congdon*. Fresno County: Sequoia Mills, *T. S. Brandegee* (no. 107425 in Herb. Univ. Calif.). Tulare County: Middle Tule River, 1700–2000 m., *Purpus*, no. 5603; Giant Forest, *K. Brandegee* (no. 126022 in Herb. Univ. Calif.).

22. **Ph. vallicola** Congdon in Brand, Beiträge, 7 (1911).—

Mariposa County (nicht Tulare County, wie irrtümlich in der Originalbeschreibung steht): Hites Cove, *Congdon* (nos. 126001, 126012, u. 133062 in Herb. Univ. Calif.); near Hennessey Ranch, *Lambert*.

23. **Ph. orogenes** Brand l. c.—Tulare County: vicinity of Mineral King, moist hillside on Eagle Lake Trail, 2750 m., *Hall & Babcock*, no. 5354.

24. **Ph. Lemmonii** A. Gray, Syn. Fl., ii, 1, Suppl., 417 (1886).—Inyo County: Argus Mountains, moist soil, 1300–1700 m., *Purpus*, no. 5445; *Hall & Chandler*, no. 7070.

25. **Ph. mohavensis** var. **exilis** A. Gray Syn. Fl., ii, 1, 165 (1878).—Tulare County: Long Meadow, 2300 m., *Hall & Babcock*, no. 5111.

C. SECTIO MICROGENETES

26. **Ph. Ivesiana** Torr. in Ives Colorado Exp. Bot., 21 (1860).—Lassen County: Susanville, *Lemmon*.

27. **Ph. Fremontii** Torr. l. c.—Inyo County: Nelson Range, *Hall & Chandler*, no. 7147. Tulare County: South Fork of Kern River, 700–1000 m., *Purpus*, no. 5716. Kern County: Tehachapi Mountains, *K. Brandegee* (no. 107303 in Herb. Univ. Calif.).

28. **Ph. bicolor** Torr. ex Wats. Bot. King, 255 (1871).—Lassen County: Honey Lake, *T. S. Brandegee* (no. 107370 in Herb. Univ. Calif.). Sierra County: *Lemmon*, no. 173. Washoe County (Nevada): Reno, *T. S. Brandegee* (no. 107305, Herb. Univ. Calif.). Ormsby County (Nevada): near Carson City, *Anderson*, no. 162; Eagle Valley, 1446 m., *Baker*, no. 1021. Mono County: Mono Lake, *Congdon*. Inyo County: sand flats near Bishop Creek, 2000 m., *Hall & Chandler*, no. 7253; foothills west of Bishop, on the banks of a small stream shaded by shrubs, *Heller*, no. 8285.

29. **Ph. gymnoclada** Torr. l. c.—Sierra County?: *Lemmon*, 1875 (Herb. Washington).—Mono County: Mono Lake, *Congdon*, no. 250.

5. MILTITZIA

1. **M. glandulifera** (Torr.) Heller, Muhl., viii, 20 (1912).—*Emmenanthe glandulifera* Torr. in Wats. Bot. King, 257 (1871).—Nevada: Reno, *Jones*, no. 3986; *Davy*, no. 3409; *Heller*, no. 8637; *Curran*.

Var. **californica** Brand var. nov.—Folia usque ad rachin pinnata partita (in typo pinnatifida tantum vel subintegerrima). Flores paulo maiores quam in typo; calyx eglandulosus.—Lassen County: Madeline Plains, *Bruce* (no. 2135 in Herb. Univ. Calif. type); *Applegate* (no. 895 in Herb. Washington). Einziger bisher bekannter Standort.

6. **EMMENANTHE**

1. **E. penduliflora** Benth. in Trans. Linn. Soc., xvii, 281 (1834).—Amador County: foothills near Drytown, *Hansen*, no. 267. Ohne Angabe, aber wohl von der Sierra, *Bridges*, no. 243. Diese an der Küste weit verbreitete Art scheint auf der Sierra nur ganz vereinzelt vorzukommen.

7. **LEMMONIA**

1. **L. californica** A. Gray in Proc. Amer. Acad., xii, 162 (1877).—Kern County: Kernville, *T. S. Brandegee* (no. 125797 in Herb. Univ. Calif.); Greenhorn Mountains, 2000–2300 m., *Palmer*, no. 50 in Herb. Boissier. Walkers Pass, sandy soil, 1300–1700 m., *Purpus*, no. 5722. Kern County?: mountains east of Erskin Creek, sandy plains, 1700–2000 m., *Purpus*, no. 5057.

8. **ERIODICTYON**

1. **E. californicum** (Hook et Arn.) Greene in Pittonia, ii, 23 (1889).—Eldorado County: Simpsons Ranch, *K. Brandegee* (no. 126025 in Herb. Univ. Calif.). Amador County: 700 m., *Hansen*, nos. 187, 1376 u. 1647.

f. **linearis** Brand form. nov.—Folia 6–15 mm. lata (in typo 10–35 mm. lata).—Siskiyou County: Yreka, *Heller*, no. 7996.

9. **NAMA**

1. **N. aretioide** (Hook & Arn.) Brand comb. nov.—*Conanthus aretioides* Watson Bot. King, 256 (1871).

Conspectus formarum

A. Corolla 14–15 mm. longa, infundibuliformis, heterostyla

(a) Planta caespitosa f. *nevadensis*

(b) Planta diffusa ramosa f. *multiflora*

B. Corolla 9–10 mm. longa, tubiformis f. *californica*

f. **nevadensis** Brand form. nov.—Ormsby County (Nevada): Eagle Valley, 1446 m., *Baker*, no. 1025; near Carson City, *Anderson*, no. 164.

f. **multiflora** (Heller) Brand comb. nov.—*Conanthus multiflorus* Heller in *Muhlenbergia*, ii, 238 (1906).—Inyo County: foothills west of Bishop, *Heller*, no. 8286. Mountain Spring Cañon, Argus Mountains, sandy places, *Purpus*, no. 5029.

f. **californica** Brand form. nov.—Sierra County, *Lemmon*, no. 174 in Herb. Boissier.

Die typische Form (corolla 11–13 mm. longa, fere campanulata) kommt nur in Oregon vor.

2. **N. densum** Lemmon in Bull. Torr. Bot. Club, xvi, 222 (1889).—*Conanthus parviflorus* Greenman in *Erythea*, vii, 117 (1899).—Siskiyou County: near Edgewood on loose volcanic soil. *Lemmon* (no. 57351 in Herb. Univ. Calif.).

3. **N. demissum** A. Gray in Proc. Amer. Acad., viii, 283 (1870).—Lassen County: Honey Lake, *T. S. Brandegee* in Herb. Boissier. Inyo County: foothills west of Bishop, *Hall & Chandler*, no. 7275; *Heller*, no. 8280.

4. **N. depressum** Lemmon ex A. Gray in Proc. Amer. Acad., xx, 304 (1885).—Inyo County: near Independence, *Hall & Chandler*, no. 7293. Kern County, Kernville, *T. S. Brandegee* (no. 107220 in Herb. Univ. Calif.).

5. **N. Rothrockii** A. Gray, Bot. Calif., i, 621 (1876).—Tulare County: Kern River, *Baker*, no. 4682; Trout Meadows, *Hall & Babcock*, no. 5411; Olancha Mountains, 2900 m., *Hall & Babcock*, no. 5262.

6. **N. Lobbii** A. Gray in Proc. Amer. Acad., vi, 37 (1862).—Siskiyou County: Mt. Shasta, *Canby*, no. 207; near Sisson, *Heller*, no. 8050. Shasta County: lava beds, 1300 m., *Hall & Babcock*, no. 4234. Sierra County: Webber Lake, *Lemmon*; Sardine Lake, 2000 m., *Hall & Babcock*, no. 4490. Nevada County: Donner Lake, *Greene*; Soda Springs, 2300 m., *Jones*, no. 2496. Washoe County (Nevada), 2200 m., *Hall & Chandler*, no. 4556. Placer County: Cisco, *Kellogg*; ebendort, on rocks above snow sheds, 2000 m., *Walker*, no. 1490.

10. **TRICARDIA**

1. **T. Watsonii** Torr. ex Wats. Bot. King, 258 (1871).—Nevada County: near Truckee, *Watson*, nach Jones in Bull. Torr. Bot. Club, ix, 116 (1882). Inyo County: low hills north of Darwin, 2000 m., *Hall & Chandler*, no. 7112.

11. **HESPEROCHIRON**

1. **H. californicus** (Benth.) Wats. Bot. King, 280 (1871).

Conspectus formarum

- A. Pedunculi glabri; folia marginibus ciliatis, alioquin glabra. Corolla 16–17 mm. longa var. a. *Benthamianus*
 B. Pedunculi pilosi
 (a) Folia cum petiolo 10–12 cm. longa, ca 2 cm. lata. Corolla 20–25 mm. longa var. b. *strigosus*
 (b) Folia cum petiolo 3–8 cm. longa; corolla plerumque minus quam 20 cm. longa
 a. Lamina foliorum multo longior quam petiolus var. c. *latifolius*
 b. Lamina foliorum brevior vel paulo longior quam petiolus var. d. *Watsonianus*

Var. a **Benthamianus** Brand var. nov.—Siskiyou County: headwaters of the Sacramento River, *Soc. Oregon* no. 1135 in Herb. DC. Mariposa County: Yosemite Valley, Herb. Univ. Calif.

Var. b. **strigosus** (Greene) Brand comb. nov.—*Capnorea strigosa* Greene in *Pittonia*, v, 45 (1902).—Plumas County: Red Clover Valley, *Heller*, no. 8748, ex parte. Sierra County: Sierra Valley, *Lemmon*, no. 177.

Var. c. **latifolius** (Kellogg) Brand comb. nov.—*H. latifolius* Kellogg in *Proc. Calif. Acad.*, v, 44 (1873).—Placer County: banks of Yuba River, *K. Brandegee* (no. 112844 in Herb. Univ. Calif., type). Placer County: *Mrs. Hardy*.

Var. d. **Watsonianus** (Greene) Brand comb. nov.—*Capnorea Watsoniana* Greene l. c., 44.—Plumas County: Red Clover Valley, *Heller*, no. 8748, ex parte. Ormsby County (Nevada): Kings Cañon, 1700–2000 m., *Baker*, no. 902. Tulare County: Olancho Mountain, Monache Meadows, *Hall & Babcock*, no. 5215.

Die Varietäten b–d sind schwer auseinanderzuhalten.

2. **H. pumilus** (Dougl) T. C. Porter in Hayden, Geol. Rep., 768 (1872).

Conspectus formarum

- | | |
|-------------------------------------|--|
| A. Folia marginibus exceptis glabra | |
| (a) Corolla 20–30 mm. lata | var. a. (<i>genuinus</i>) |
| (b) Corolla minus quam 20 mm. lata | var. b. <i>ciliatus</i> |
| B. Folia supra hirtella | |
| (a) Pili pedunculorum adpressi | var. c. <i>vestitus</i> |
| (b) Pili pedunculorum patentes | (f. 1. <i>villosula</i>)
f. 2. <i>hirtella</i> |

Die typische Form fehlt auf der Sierra.

Var. b. **ciliatus** (Greene) Brand comb. nov.—*Capnorea ciliata* Greene l. c.—“High Sierras,” Lemmon (als “*Hydrophyllum capitatum*” in Herb. DC.).—“Big Meadows,” Lemmon (“New to California”; Herb. Boissier).

Var. c. forma 2. **hirtella** (Greene) Brand comb. nov.—*Capnorea hirtella* Greene l. c. 51.—Mariposa County: Yosemite Valley, *Blasdale* (no. 30130 in Herb. Univ. Calif.).

3. **H. campanulatus** (Greene) Brand comb. nov.—*Capnorea campanulata* Greene l. c. 52.—Fresno County: North Fork of Kings River, 2500 m., *Hall & Chandler*, no. 550

Das Genus **Romanzoffia** scheint auf der Sierra Nevada zu fehlen.

ALGAE NOVAE ET MINUS COGNITAE, I

BY

WILLIAM ALBERT SETCHELL

***Pleurocapsa conferta* (Kuetz.) comb. nov.**

Palmella conferta Kuetzing, Phyc. Germ., p. 149, 1845; Tab. Phyc., vol. 1, p. 12, pl. 16, fig. iv, 1845-49; Spec. Algarum, p. 213, 1849.

Pleurocapsa amethystea var. Johs. Schmidt, in H. Jonsson, Mar. Alg. Iceland, iv, p. 378, 1903; Mar. Alg. East Greenl., p. 70, 1904. Borgesen, Mar. Alg. Faeroes, p. 524, 1902 Forti, in De Toni, Syll. Alg., vol. 5, p. 121, 1907.

There occurs on *Rhodochorton Rothii*, on both coasts of the United States, and on the west (or northwest) coasts of Europe, a not infrequent epiphyte, which has come to be known as a variety of *Pleurocapsa amethystea* Rosenv. The type of the species of Rosenvinge is found on *Rhizoclonium riparium* f. *validum* (cf. Rosenvinge, *Groenl. Havalger*, p. 967, fig. 57, 1893). Whether the epiphyte on *Rhodochorton* is specifically identical or not, is not to be settled in this article. An examination of the description by Schmidt and of a specimen distributed by Boergesen (no. 546) from the Faeroes, together with a comparison with the type specimen of *Palmella conferta* Kuetzing, which I have been able to make through the kindness of Mme. Weber-van Bosse, convinces me that the two plants are the same. Consequently I have proposed the new combination *Pleurocapsa conferta*.

Pleurocapsa conferta is described superficially by Kuetzing (*Phyc. Germ.*, p. 149) as forming microscopic, green, and firm masses which surround the filaments of the host with a papillose mass containing very small "gonidia." The type locality is

given as Cuxhaven, on the North Sea shore, Germany. The figure given by Kuetzing in the *Tabulae Phycologicae* (vol. 1, pl. 16, fig. iv, 2) is also good and convincing.

The description given by Johs. Schmidt in Helgi Jönsson's paper on the *Marine Algae of Iceland* (iv, p. 378) is both full and exact. He deals also with the relationship existing between his unnamed variety and the *Pleurocapsa amethystea* of Rosenvinge (*Groenl. Havalger*, loc. cit., and *Alg. Mar. du Groenl.*, p. 163, fig. 57, 1894). The form on *Rhodochorton Rothii* passes through just such stages as indicated in Rosenvinge's figures but proceeds farther as indicated by Schmidt. The color in the earlier stages is usually more bluish, often deep blue, even at times the bluish purple of the amethyst, but the cell contents of the later stages are a dirty verdigris green. The walls and surrounding jelly are hyaline. The cells become smaller and smaller as division proceeds.

It appears from my own examinations, that this species is probably coincident in its range with its host. In North America it occurs on the north shore of New England (Collins!, Setchell!) as well as on the south coast (Holden!), and on the Pacific coast of North America it ranges from St. Michael, Alaska (Setchell!) down to Monterey, California (Setchell!, Nott!) at least. Especially good colonies of *Pleurocapsa conferta* are abundant in the specimen (of my copy at least) distributed under no. 49 of the *Phycotheca Boreali-Americana* (Nahant, Mass., Setchell!) and fair representatives under no. LVI of the same distribution (Monterey, California, C. P. Nott!).

Brachytrichia Quoyi (Ag.) Bornet is credited to the coast of California by Bornet and Flahault (*Rev. Nost. Het.*, ii, p. 373, 1886,) on the authority of a specimen collected by (or communicated by) Grunow. It seems to have escaped other collectors, so far as I know, at least, but a specimen was collected in August, 1911, by J. E. Guernsey at Laguna Beach in Orange County, California. It seems to be typical and agrees with specimens from the East Indies in habit and structure.

The genus *Coilodesme* was founded by Stroemfelt in 1886 to receive an Icelandic plant to which he gave the name *C. bulligera* (*Algveget Isl.*, Kuster, p. 48, pl. 2, figs. 9-12). It was enlarged

by Kjellman (*Undersök. of någ till Slägt. Adenocytis*, p. 4, figs. 1-8, 1889,) to receive a plant imperfectly described by Ruprecht as var. *californica* under *Adenocystis Lessonii* (*Tange Och.*, p. 291, 1851). A third species was added by De Alton Saunders (*Algae [of the Harriman Expedition]*, p. 421, pl. 48, 1901), who gave it the name of *C. linearis* but which Setchell and Gardner (*Algae N. W. America*, p. 241, 1903) later identified as the *Asperococcus Cystoseirae* Ruprecht (*Tange Och.*, p. 370, 1851) and changed the name to *C. Cystoseirae*. The genus consequently, has three species attributed to it.

For some time there has existed in my mind a doubt as to the exact identity of *Coilodesme californica* (Rupr.) Kjellm. De Alton Saunders described and figured a plant under this name (*Proc. Calif. Acad. Sci.*, ser. 3, Bot., vol. 1, p. 160, pl. 29, figs. 1-3, 1898) which is common on the coast of California on *Cystoseira Osmundacea*. It is a plant which often reaches a large size, is cylindrical at first, but collapses more or less later, is thin walled and wrinkled. Its color is light yellowish brown, changing often to an olive green in drying. It has been distributed in Collins Holden and Setchell, *Phycotheca Boreali-Americana* under no. I, and in Tilden's *North American Algae*, under no. 354.

There is, however, still another species of *Coilodesme* existing on the coast of California and also found growing upon the fronds of *Cystoseira Osmundacea*. This species never reaches the size of the last, is smooth, firm, comparatively thick-walled, strongly flattened, and of a dark brown color, even from the first. It looks very much like *Halosaccion fucicola*, but is brown and flattened. On comparing the descriptions of Ruprecht (*loc. cit.*) and of Kjellman (*loc. cit.*), it seems fairly certain that it is this flattened, smooth, dark brown plant which is to be referred to *Coilodesme californica*, leaving the ample, thin, wrinkled, and lighter colored plant as an undescribed species. The four species of *Coilodesme*, thus distinguished, may be arranged as follows:

FRONDS FLATTENED, LONG STIPITATE, FIRM, DARK BROWN

1. *C. bulligera* Stroemf. More or less swollen and bullate, especially on the edges.

Stroemfelt, *Algveget. Isl. Kuster*, p. 48, pl. 2, figs. 9-12, 1886.
Phycotheca Boreali-Americana, no. 923, 1902!

2. *C. californica* (Rupr.) Kjellm. Flattened and smooth on the edges, not at all swollen.

Ruprecht, Tange Och., p. 291, 1851 (sub *Adenocystis* (*Lessonii* var.?) *californica*.)

Kjellman, Undersökn. af någ. till Slägt. *Adenocystis*, p. 8, figs. 1-8, 1889.

FRONDS INFLATED, VERY SHORT STIPITATE, CYLINDRICAL, WRINKLED,

THIN AND MEMBRANACEOUS, LIGHT BROWN

3. *C. Cystoseirae* (Rupr.) Setchell & Gardner. Elongated, narrowly cylindrical.

Ruprecht, Tange Och., p. 370, 1851 (sub *Asperococcus Cystoseirae*).

Saunders, Algae (of the Harriman Expedition), p. 421, pl. 48, 1901, and in *Phycotheca Boreali-Americana*, no. 824, 1901 (sub *Coilodesme linearis*).

Setchell & Gardner, Algae N. W. America, p. 241, 1903; *Phycotheca Boreali-Americana*, no. 1128, 1903.

4. *C. amplissima* sp. nov. C. thallo amplo, ad 30 cm. alto et 7.5 cm. lato, late cylindrico, apice obtuso rotundatoque, basi contracto brevissimo-stipitatoque, cavo, primum inflato demum collabente, irregulariter undulato, luteo-fusco; parietibus tenuibus, membranaceis.

Saunders, Proc. Calif. Acad., ser 3, Bot., vol. 1, p. 160, pl. 29, figs. 1-3, 1898; *Phycotheca Boreali-Americana*, no. I, 1899 (both sub *C. californica*).

Tilden, Amer. Algae, no. 354, 1900 (sub *C. californica*).

From Yakutat Bay, Alaska (Saunders) to San Pedro, California (Mrs. S. P. Purdy!), growing on *Cystoseira Osmundacea* and *Cystophyllum geminatum*.

There is little need for giving a detailed description of *C. amplissima*, since it is really the plant better known than *C. californica*. The figure of Saunders, and the specimens distributed, make plain what is meant. By the thinness of its membrane, lack of flattening, particularly in the early stages, its very short stipe (2 mm. or less), it is clearly allied to *C. Cystoseirae* and quite distinct from *C. bulligera* and *C. californica*. In distribution on the Pacific coast of North America, *C. bulligera* and *C. Cystoseirae* occupy the northern portion, while *C. californica* and *C. amplissima* occupy the southern portion. It may be that *C. amplissima* will be found to pass over into the forms of *C. Cystoseirae* (cf. Setchell & Gardner, *loc. cit.*, p. 241), but it seems best to keep it distinct at present.

HAPTEROPHYCUS Setchell et Gardner gen nov. Ralfsiacearum

Frons decumbens, dorsiventralis, orbicularis; ramis e centro radiantibus, obesis, curtis, dichotomo multiplo ramosis, infra canaliculatis, marginibus crenatis, axillis latis rotundisque, apicibus latis obtusisque; soris sub cuticulo orientibus mox superficialibus, latis et inconspicuis; sporangiis (unilocularibus) pyriformibus, lateralibus in cellulis basilaribus paraphysium multicellularum multo superantium; intus frons cellulis magnis, cylindricis, hyalinis, in seriebus ad superficiem e planitie horizontali media utrinque curvatis, compositis; cellulis superficialibus parvioribus endochromatibus faretis; gametangiis ignotis.

H. canaliculatus Setchell and Gardner sp. nov.

Frondebis ad 5 cm. latis, luteo-fuscis; sporangiis 65–75 μ longis, 18–25 μ latis; paraphysibus 4–7-cellularibus, 6–7 μ latis.

In saxis, intra limites fluxuum maris, apud "San Pedro," in ditione Californiensi, ubi detexit N. L. Gardner.

The new genus and species here proposed was found by Dr. N. L. Gardner, growing on rocks in the litoral zone in the neighborhood of San Pedro, California. On the rocks it looks so much like the holdfasts of some member of the Laminariaceae, that it seems fitting to choose for it the generic name given above. Radiating from the center, the short, stout, dichotomous branches, with broad rounded axils and broad, blunt tips (pl. 25, figs. 1 and 2) counterfeit the hapteres of such a kelp as *Egregia Menziesii* or *E. laevigata* most exactly. The texture is firm and the color, when young, a light yellow brown, darkening with age or on drying. The inner structure is parenchymatous and very much like that of *Ralfsia deusta*. The rows of cells, as seen in section, curve from a middle plane towards each surface (pl. 25, fig. 3). The meristematic region for increase in length is broad and situated at the ends of the branches. The sori, containing the sporangia, are broad and make no visible sign of their presence. They consist of pear-shaped unilocular sporangia which are borne on the same basal cells with the multicellular paraphyses which far overtop them (pl. 25, fig. 4). At first the sorus is covered by the cuticula, but this is soon sloughed and the paraphyses are uncovered (pl. 25, fig. 3.) No sign of gametangia (plurilocular sporangia) has been seen in any of the specimens

examined. The plants are only loosely attached to the substratum and the branches are channeled below (pl. 25, fig. 2).

The genus *Hapterophycus* must belong in either the Ralfsiaceae or the Chordariaceae, as at present understood. Perhaps these two orders should be united. If kept separate, the affinities of *Hapterophycus* seem clearly with the Ralfsiaceae, differing only from the genera now included in that order by the branches being free instead of completely (or nearly completely) coalescent. In fact, *H. canaliculatus* has many points in common with *Ralfsia deusta*, whose loose attachment to the substratum and imbricated and often deeply lobed margins seem to connect the genus *Ralfsia* with *Hapterophycus*. There is a certain superficial resemblance between *H. canaliculatus* and *Cylindrocarpus Berkeleyi*, but the microscopic structure of the two species is quite different. *Hapterophycus* has also some considerable resemblance to the basal portions of *Analipus* and *Caepidium*, but is certainly not identical with either of those genera.

***Callymenia oblongifructa* comb. nov.**

Iridaea oblongifructa Setchell. Notes on Algae L, Zoe, vol. 5, p. 123, 1901; Setchell & Gardner, Algae Northwestern America, p. 300, 1903.

When in 1901 I described a plant sent by N. L. Gardner from Whidbey Island, Washington, as *Iridaea oblongifructa*, I relied upon the habit and the internal structure to refer it to the genus *Iridaea*. The cystocarp also seemed more diffuse, like that of *Iridaea* rather than of *Callymenia*. I did not, at that time, observe the procarps, nor did I find the tetrasporangia. In 1903 Gardner and myself, in publishing our "Algae of Northwestern America," expressed the opinion that it might be a species of *Callymenia*.

Since then, I have been able to examine other specimens and to make further studies, with the result that I am certain that the species must be removed from *Iridaea* into *Callymenia*, where it forms a distinct species.

Callymenia oblongifructa, even yet, is a very little known plant. It is usually obtained in fragments, often of large size, but still incomplete. Young plants, seemingly of this species,

have been collected, but, since they are sterile and much thinner than the adult type, their identification is not so certain as could be desired.

In general, it seems certain that *C. oblongifructa* has the habit and appearance of a species of *Schizymenia* or of *Dilsea*. Arising from a broad fleshy disk, the plant soon broadens to ovate or even to cordate, and then grows on into a frond which is much longer than it is broad. It certainly reaches a length of 75 centimeters and a breadth of at least 30 centimeters. As the plants giving these measurements were fragments of a larger plant, it seems equally certain that plants must exist with measurements even considerably greater than these. At first the frond is undivided, but later splits to the very base.

The texture is firm and membranaceous when dry, becoming more or less fleshy when the dried plant is soaked in fresh water. Some individuals deliquesce more or less completely after a time in the "soaking out" process, but others remain intact. The color varies from dark red to light red, but the latter color seems to belong particularly to "weathered" specimens. The surface is very delicately marked by coarse but very slightly elevated wrinkles running out flabellately from the base. This character of the surface, while slight and often obscure, often serves to identify a sterile specimen. The thickness of the adult frond varies in the same frond from about 210μ to 550μ , but large specimens, which are however still young, are often not over 150μ or 200μ in thickness. On account of the delicate wrinkling, the thickness varies considerably in the same frond and within short distances.

The internal structure has a certain fairly close resemblance to that of true species of *Iridaea*. It varies somewhat, according to age and condition, and such variation may be found even in the same frond. The general course of the slender (or, at times, coarser) filaments of the medulla is longitudinal, but there are oblique cross connections at frequent intervals making more of a reticulum, or at least a looser one, than is usual in species of *Callymenia*. The cortex on each side is thin, as compared with the medulla. It consists of about five layers of cells loosely but regularly placed in the surrounding jelly, and decreasing in size,

while increasing in color, as they approach the surface. A fairly thick and transparent cuticula clothes the surface.

The cystocarps are broad and deep-red, a very little, and equally, prominent on both surfaces. The "nuclei" or spore clusters are small and well separated from one another. Procarpic branches are fairly abundant and easily detected. In addition to the procarp, they consist of about five cells much elongated laterally and of the general character of those of *Callophyllis* (cf. Hauptfleisch in Engler & Prantl, *Die natürl. Pfl.-fam.*, 1 Th., Abth 2, fig. 220D, 1896) and of *Erythrophyllum* (cf. Twiss, *Univ. Calif. Publ. Bot.*, vol. 4, pl. 24, fig. 11, 1911). The structure of the procarpic branch assists very materially in deciding the position as between *Iridaea* and *Callymenia*.

The tetrasporangia are scattered through the cortex and occur in plants somewhat thinner (400–420 μ thick) on the average than the cystocarpic plants. They are oblong, 18–21 μ high by 14–16 μ broad, and are divided in the tripartite-cruciate fashion.

C. oblongifructa differs from all the other species of *Callymenia* known from our western coasts in habit, color, thickness, and details of internal structure. It belongs to the section of the genus, to which J. G. Agardh (*Anal. Alg.*, p. 65, 1892) assigned the name *Euhymenia*, so far as internal structure is concerned and the position and influence of the cystocarp on the frond is concerned. It differs sufficiently from all the species of that section, however, in its simple habit to render farther comparison unnecessary.

C. oblongifructa has been found on the shores of Whidbey and San Juan Islands in the State of Washington as well as near Sitka, Alaska, by N. L. Gardner, and near Seldovia, Alaska, by C. V. Piper.

BESA gen nov. Gigartinacearum

Frons epiphytica (aut hemiparasitica), elongato-papillaeformis aut clavata, simplex aut parce lobata, laete rubra, cystocarpis adultis frondem fere complentibus, nucleis distinctis multis per cellulis sterilibus magnis segregatis compositis, carpostomio proprio nullo; antheridiis tetrasporangiisque adhuc ignotis.

B. papillaeformis sp. nov.

Frondibus gregariis aut sparsis, 0.28–0.48 mm. altis et ad 0.38 mm. latis, carnosio-cartilagineis et in frondibus crustaceis rubris *Hildenbrandtia*(?) epiphyticis (aut hemiparasiticis).

In zona litorali, apud San Francisco, in ditione Californiensi, ubi detexit W. A. Setchell.

It has seemed best to name this extremely minute plant after the Egyptian god Bes, whose Greek name *Βήσα* has been adopted into Latin unchanged. He is always represented as a dwarf and extremely small even at that.

I first detected this plant growing in small groups on a crustaceous red alga, probably a species of *Hildenbrandtia*, which covered the rocks in the upper middle litoral zone at the locality known as Land's End, at the northern extremity of San Francisco, California, in January, 1909. Its color is very slightly lighter than that of the *Hildenbrandtia* on which it is growing and it is due to this fact that it attracted my attention.

The fronds are simple and clavate or somewhat compound, being more or less deeply lobed as shown in plate 25, figure 5. They do not reach a height of much over half a millimeter at most. They are attached to the substratum by a broad base (pl. 25, fig. 6), whose basal cells have protoplasmic connection with the cells of the host plant. The development of *Besa papillaeformis* begins, and progresses for a short time, under the cuticula of the host, at length breaking through. The cuticula of the host may be seen in sections of the adult specimens still covering the bases at the sides (pl. 25, fig. 6). It is this behavior of the plant in breaking through the cuticula, as well as the difference in the consistency and cell structure of the papilliform body, which leads me to regard it as a hemiparasite and not as the fruiting body of the crustaceous red alga upon which I have always found it growing. This crustaceous red alga seems, from its structure, to be a species of *Hildenbrandtia*, but I have not been able as yet to find any fruiting bodies of any sort upon it.

The young and sterile plants are slender and cylindrical or clavate, while the cystocarpic plants are swollen above and come to be obovate. In the older plants, the central cells are elongated and the central strands become almost filamentous.

Procarys are very abundant in plants of the proper stages of which I have observed a few. They are simple, curved, of about three cells ending in a long trichogyne. The basal cell probably functions as an auxiliary cell, but the details of development have not been traced.

The cystocarps are large for the size of the plants and come to occupy the greater part of it. They are the typical "compound cystocarps" of the Gigartinaceae and are well represented in figure 6 of plate 25. The various spore masses are separated from one another by large sterile cells and there is no distinctly marked-off and special enveloping tissue. The whole structure of the plant, of the cystocarp, and of the procarp, indicate that *Besa papillaeformis* is to be placed in Gigartinaceae, under the family Gigartineae, and near the genus *Gigartina* itself.

There is a certain resemblance in habit (taking plant and 'host together) to *Dermocorynus Montagnei* Crouan, but the resemblance apparently stops there, since that species is described as having the structure of frond and cystocarp of the Grateloupiaceae.

Thus far I have detected *Besa papillaeformis* only at the single locality mentioned above, but I have collected it there on several different occasions. It will probably be found in other similar situations on the coast of middle California at least, escaping notice on account of its microscopic size.

***Faucheia laciniata* forma *pygmaea* Setchell et Gardner,**
forma nova

F. laciniata forma colore et structura frondis cystocarpiorumque ut in planta typica sed frondibus pygmaeis, 1-3 cm. altis, rosulatis, compactis, et condensatis; cystocarpiis numerosissimis, in paginis utrisque aggregatis; nematheciiis efformatis, latis.

In corallinaceis articulatis, in zona litorali inferiore apud "San Pedro," in ditone Californiensi, ubi detexit N. L. Gardner.

It seems proper to call attention to, and to bestow a name upon a set of plants which seem clearly to belong to *Faucheia laciniata*, but which possess a particular and distinctive habit due apparently to their environment. These plants are very

much dwarfed and compacted into rosulate tufts. The thallus is condensed, so that the branches are shorter and the whole habit more compact. There seems to be no particular distortion, and the microscopic structure seems entirely normal. The dwarf plants show abundant cystocarps, which are coronate and very thickly placed on both surfaces. I have seen only a few tetrasporic plants. They are small (about 1 cm. high) and the nemathecium resemble those first formed in typical *F. laciniata*, being broad patches but without any regular or fixed outline or arrangement.

The f. *pygmaea* grows chiefly on jointed corallines which form a zone at the lower tide mark or just below. They have other dwarf (or dwarfed) forms on them and are accompanied by pigmies of other algae as well, thus making a characteristic formation. The *Fauchea*(?) *mollis* Howe alluded to below may possibly belong to this form, although its being sterile seems to indicate, rather, that it may more likely prove to be a juvenile state of *F. laciniata*.

***Fauchea Fryeana* sp. nov.**

F. fronde solitaria (aut caespitosa?), usque ad 34 cm. diam., in circumscriptione late aut moderate reniformi, vinoso-rubra, cartilagineo-membranacea, e disco radicali; stipite brevi, ad 12 mm. alta; fronde ampla, flabellatim expansa, e basi et superne repetite dichotomo-dissecta; segmentis inferne lente attenuatis, inferioribus latioribus, superioribus angustioribus, ultimis numerosissimis, acutis, lateraliter grosse dentatisque; fronde 100–360 μ crassa, stratis tribus composita,—strato medullari cellulis magnis in centro extus parvioribus, stratis corticalibus duobus. cellulis, parvis, elongatis, coloratisque, sphericis, in seriebus antichinis moniliformibusque dispositis; tetrasporangiis in nemathecis indefinitis sed elongatis flabellatim radiantibusque, in partibus inferioribus, triangulo divis, paraphysibus multicellularibus superantibusque comitatis, omnibus in gelina crassa hyalinaque involutis; antheridiis adhuc ignotis; cystocarpis margines segmentorum omnium majorum occupantibus, dense confertis, urceolatis, apice quoque in collo longo attenuato, intus placentis basilaribus nucleos sporarum conglobatarum gerentibus, pericarpis intus filamentis late reticulatis compositis, peristomiis latis.

In zona sublitorali, "Friday Harbor" et vicinis, in ditone Washingtoniensi, ubi detexerunt Prof. T. C. Frye et Dr. N. L. Gardner.

There are already two species of this genus known from the same general region as the one described, viz., *Faucheia laciniata* J. Ag. and *F. Gardneri* Setchell. *F. Fryeana* differs from both of these in both the cystocarpic and the tetrasporic plants. *F. laciniata* belongs to the section of the genus having coronate cystocarps. They are also scattered over both surfaces of the frond. The nemathecium in *F. laciniata* are also different, at least in general aspect, from those of *F. Fryeana* (cf. Setchell & Gardner, *Algae of Northwestern America*, pl. 19, fig. 30, 1903). The type of *F. laciniata* in Herb. J. Agardh, at Lund, is from Santa Barbara. It is cystocarpic and the cystocarpic specimens from Puget Sound have been compared with it and agree closely. *F. Gardneri* has cystocarps which lack a corona, but they are also scattered over both surfaces of the frond. The nemathecium of *F. Gardneri* are small and irregular in shape and scattered over both surfaces in a grapheiform fashion (cf. Setchell & Gardner, *loc. cit.*, pl. 25, fig. 43). The cystocarps of *F. Fryeana* are strictly marginal and so closely placed that they give the margins a decidedly fimbriate appearance (cf. fig. 13, pl. 31). They are sometimes, also, situated in short and slender process projecting a few millimeters from the margin in older (or at least larger) plants, and when this condition is present it heightens the fimbriate appearance.

Howe (*Bull. Torrey Botan. Club*, vol. 38, p. 506, pl. 31, 1911) has just described a new species of *Faucheia*, under the name of *F. Sefferi*, which has marginal cystocarps which are not coronate, and this species is to be most seriously considered in comparison. It is very much narrower than any specimens of *F. Fryeana* seen among our specimens, is of entirely different aspect, and is more striking in its dichotomy, characters which, from the study of a considerable variety of *Faucheia* material, appeals to me as being reasonably constant. Unfortunately, Howe did not have any tetrasporic plants of his species, so that full comparison cannot be made. This is to be regretted, since, in our Pacific Coast species, the character of the nemathecium assist greatly in identification. It seems, however, perfectly safe to consider our plant as being quite distinct from the *F. Sefferi* of California Baja.

Young and tetrasporic plants of both *F. laciniata* and *F. Gardneri* are broader, thinner, brighter or deeper colored than older and cystocarpic plants. The tetrasporic plants of *F. Fryeana* (cf. fig. 14, pl. 31) are mostly very young or, even the oldest of them, not very old. They resemble in habit and characters of thickness the *Fauchea*(?) *mollis*, described from young, sterile specimens by Howe (*loc. cit.*, p. 507, pl. 32; pl. 33, fig. 6). The young plants of *F. laciniata* also resemble in habit characters *F.*(?) *mollis*. It will be impossible to determine definitely just what *F.*(?) *mollis* really is until it has been traced into its adult forms. If it should happen that *F.*(?) *mollis* prove to be identical with any one of the three species of the coast of the United States, it seems not unlikely, since several of the species described by Howe from La Paz are found also on our Southern California coast, that it may prove to be a young plant of *F. laciniata*, whose type locality is Santa Barbara, California, rather than either one of the other two, which, thus far at least, have been found only in the colder waters of Puget Sound. In thickness and structure of the frond, young plants of *Fauchea laciniata* agree exactly with the descriptions of *F.*(?) *mollis*, while young plants of *F. Fryeana* differ only in the more distinctly anticlinal rows of the cortex. In structure and habit, young plants of *F. Gardneri* are decidedly different from *F.*(?) *mollis*.

It seems best, after due consideration, to propose *Fauchea Fryeana* as a new species, as was done by letter some several years since, and to name it in honor of Professor T. C. Frye of the University of Washington, who sent me the first specimens. The types are deposited in the Herbarium of the University of California and the type locality is Friday Harbor, Washington, whence also have come fine typical specimens of *F. Gardneri* and of *F. laciniata*.

***Dudresnaya caribaea* (J. Ag.) comb. nov.**

Calosiphonia caribaea J. G. Agardh, *Analecta Algologica*, cont. v, p. 84, 1899.

In working over some very interesting red algae, found floating in abundance at Coopers Island in the Bermuda Islands, by W. G. Farlow, in 1881, I found three species, two of *Dudresnaya*

and one of *Calosiphonia*, which had so general a resemblance in habit and color to one another that it was difficult to be certain, at least at first, that they could be distinct species. The microscopic structure, especially of the cystocarps and procarps, however, is sufficiently, in fact amply, distinct. A comparison with types and careful study has enabled me to enumerate and describe them in this paper with some considerable degree of confidence as to accuracy.

One of the plants corresponds exactly to the type specimen of J. G. Agardh's *Calosiphonia caribaea*, but is referable to the genus *Dudresnaya*, as indicated above.

Dudresnaya caribaea (J. Ag.) has solitary (or possibly slightly aggregated?) fronds, of a light or yellowish red color and broadly flattened ovate outline. From the discoid (or possibly expanded?) base arises a single stem which, usually, at any rate, soon loses itself in several main branches. The branches are more or less strongly complanate and pinnately distichous (or at times more or less secund); the branches themselves, being branched in turn, conformably twice (or rarely thrice) more. All the branches and branchlets taper towards each end, the ultimate branchlets being fusiform (Pl. 26, fig. 7). The structure of the frond is almost exactly that of *Dudresnaya purpurifera* J. Ag. The peripheral filaments are strongly moniliform, the cells being oblong or obovate and deeply constricted at the nodes, ditrichotomous below but only dichotomous above. I have not been able to detect tetrasporangia on any of the available specimens, and the species seems to be partially dioecious. Some specimens are smaller and paler, and have the peripheral cells over considerable areas, pale and rounded, as well as apparently discharging their contents. However, it is not certainly to be determined from dried specimens. Other specimens appear to have both antheridia and procarps on the same plant.

The procarps and auxiliary branchlets closely resemble those of *Dudresnaya purpurifera* J. Ag. Both sorts of branchlets are strongly curved, situated in the outer third of the verticil, and consisting of nine to fourteen cells. In the procarpic branch, the cells are discoid supporting a conical carpogonium which, in turn, is prolonged above into a moderately long, more or less spirally

twisted, slender trichogyne. The auxiliary branches appear to be much more numerous than the procarpic, which they resemble closely, except that the terminal cell is enlarged into a nearly spherical auxiliary cell. The cystocarps are moderate sized, from 45–90 μ in diameter, consisting of few spores, successively formed and closely crowded together.

Dudresnaya caribaea is closely allied to *D. purpurifera*, but is to be distinguished from it by its complanate frond, its much more distichous method of branching, and its rather larger, fewer spored cystocarp.

In Herb. J. G. Agardh, there are two specimens under the name of "*Calosiphonia caribaea* J. Ag.," under nos. 34781 and 34782, both marked also "ex Florida Curtiss." No. 34781 is marked "24" and "Tortugas" in pencil, and no. 34782 is marked "30" in pencil. Both plants are cystocarpic. The "Tortugas," then, off the Florida coast are the type locality. It is rather more than possible, in fact it is fairly certain, that the plants were collected by Mrs. G. A. Hall and only transmitted to Professor Agardh by Mrs. Curtiss. Through the kindness of Professor Svante Murbeck and Dr. Otto Nordstedt I was allowed to make a microscopic examination, with the result that I found both types to belong to the genus *Dudresnaya*. This came as a surprise, since there is a species of *Calosiphonia* from the Tortugas, sent by Mrs. Hall, resembling in habit the present plant, and which appears in Herb. J. Agardh as the type of *Helminthopsis verticillifera* J. Ag., as will be noted below. The suggestion is natural that the type specimens of these two species may have been transposed by Agardh. However, there are certain indications in Agardh's descriptions that he had correctly labelled his types and that his *Calosiphonia caribaea* is designated as he desired it to be. Particularly his description of the curved moniliform filament from which the cystocarp is produced serves to fix it, as well as his remarks noting its resemblance to the plant which he had long kept in his herbarium under the name of *Dudresnaya australis*, of which I shall give farther information later on in this paper.

Dudresnaya bermudensis sp. nov.

D. fronde solitaria (aut pauciaggregata), ad 9 cm. alta, ovata in circumscriptione, dilute rosea, gelatinosa; basi discoidea (aut prostrata extensaue?); axe percurrente sed ramis multis et superantibus, lente valdeve complanata, ramosa; ramis plus minusve distiche pinnatis aut secundis, compressa, ipsis 2-3-plo ramuliferis omnibus utrinque lente attenuatis; ramellis peripheralibus intus cylindraceis, extus moniliformibus; tetrasporangiis adhuc ignotis; monoica?, antheridiis(?) parvis, superficialibus, pallidis rotundisque; ramellis procarpiiferis elongatis, multicellularibus, plus minusve curvatis, cellulis discoideis et cellula carpogoniali apicali obtusa conica in trichogynum elongatum spiraliter curvatum desinente compositis; ramellis auxiliaribus elongatis, multicellularibus, simplicibus aut infra 2-3-ramelluliferis, curvatis, cellulis mediis depresso-sphericis, tumefacientibus, similibus; cystocarpis moderate magnis, 112-126 μ latis, reniformibus, integris aut obscure lobatis, pedicellis curvatis suffultis, maturitate non apiculatis.

Rejecta ab undis ad insulam "Coopers," in insulis Bermudensibus, ubi detexit cel. W. G. Farlow, in anno 1881.

The new species here proposed is one of the rich finds made in 1881 by Professor Farlow at Coopers Island, one of the Bermudas. It is of a delicate pink, soft gelatinous, and (so far as available specimens are concerned) of moderate size. In habit (pl. 27, fig. 8) and color, it approximates somewhat to *Dudresnaya caribaea*, but its procarpic and auxiliary branchlets are of the "Coccineae" rather than of the "Purpuriferae." It also has something of the appearance of *D. coccinea*, but is more complanate and distichous. It has also the moniliform peripheral ramelli of *D. purpurifera* rather than the cylindrical ramelli of *D. coccinea*. From *D. crassa*, it differs decidedly in its habit, moniliform peripheral ramelli, and the absence of a single specialized (smaller) auxiliary cell in each auxiliary branchlet. From *D. japonica* it differs abundantly in habit and also very much in the character of the peripheral and auxiliary branchlets, while from the next species (*D. australis*) it differs somewhat in habit and in details of structure of both the peripheral and auxiliary branchlets. It seems to be a distinct species of the *Dudresnayae Coccineae*, and its chief interest lies in the fact that it combines the auxiliary branchlets of the *D. coccinea*-type with the peripheral branchlets of the *D. purpurifera*-type, a fact pointed

out by Dr. Bornet in a letter to Professor Farlow many years ago. It is also of interest that it occurs in the same restricted locality with *D. crassa* and *D. caribaea*.

***Dudresnaya australis* J. Ag. sp. ined.**

J. G. Agardh in J. Bracebridge Wilson, Catalogue of Algae collected at or near Port Phillip Heads and Western Port (Proc. Roy. Soc. Victoria, new ser., vol. 4, part 2, p. 181, Nov., 1892) nomen nudum; Anal. Alg., cont. v, p. 85, 1899 (cum descr. incompl.)

D. fronde solitaria (aut pauci-aggregata), ad 13 cm. alta, late pyramidalis in circumscriptione, rosea, gelatinosa, monoica; basi discoidea (aut prostrata extensaue?); axe percurrente, gracili. tereti; ramis numerosis, quoqueversum exeuntibus, pinnatis, longis, gracilibus, patentibus, utrinque lente attenuatis, ipsis 2-3-plo ramellois, ultimis subulatis; ramellis peripheralibus conformibus, gracilibus, filiformibus, dichotomis, cellulis elongatis compositis; tetrasporangiis zonatis; ramellis auxiliaribus elongatis, cellulis mediis numero 15 proxime, tumefacientibus sed una media conspicue ut cellula auxiliari differentiata, superne ramellosis et deciduis; cystocarpis, 60-75 μ latis, reniformibus, non apiculatis.

Apud Capita Portus Phillipi et apud Portum Occidentalem in Australia, ubi detexit J. Bracebridge Wilson.

While attempting to make a critical study of the Dumontiaceae, my attention was drawn to four magnificent specimens in the Cryptogamic Herbarium of the British Museum of Natural History, belonging to the collection of J. Bracebridge Wilson, and labelled *Dudresnaya australis* J. Ag. Since J. G. Agardh had not published any description of the plant and since no true *Dudresnaya*—in fact, only one other member of the Dumontiaceae, even—was known from the Southern Hemisphere, I took up the study of Wilson's specimen with great interest..

I found that the name, and that only, had been published by Wilson in his Catalogue of Algae collected at or near Port Phillip Heads and Western Port in 1892. I also found the brief mention of the plant, made by J. G. Agardh himself, in the Continuatio V of the *Analecta Algologica* (pp. 84 and 85). Through the courtesy of Mr. A. Gepp, in charge of the cryptogamic collection of the British Museum of Natural History I was enabled to make a study of the specimens, and later, through

the courtesy of Professor Svante Murbeck and Dr. Otto Nordstedt, to compare them with the specimens in Herb. J. Agardh at Lund. The latter are three in number and correspond exactly to the specimens in the British Museum of Natural History. The Lund specimens are labelled "*Dudresnaya australis* J. Ag. *ad interim*" in J. G. Agardh's handwriting, together with notes on specimens 34730 and 34731, to the effect that J. G. Agardh had observed in these specimens the same sort of procarpic and auxiliary branchlets described by Bornet and Thuret for *Dudresnaya coccinea*. His note in the *Analecta* also makes it plain that he clearly recognized the plant as a *Dudresnaya*, but was doubtful as to its being distinct from the European *D. coccinea*.

The habit of the plant is very similar to that of *Dudresnaya coccinea*. A glance at the accompanying photograph (pl. 26, fig. 9), which was made from one of the specimens in the British Museum of Natural History through the kindness of Mr. Gepp, will show this. The structure both of the peripheral and the auxiliary filaments, however, is not that of *D. coccinea*, but very much like that of *D. crassa* as illustrated by Howe and as shown in specimens distributed by him, especially in specimens preserved in formalin, for which I am very much indebted to his kindness. The peripheral filaments are longer than those of *D. coccinea* and the auxiliary branches differ in several respects. In the first place they are very long, apparently much longer than either those of *D. coccinea* or of *D. crassa*. At the base there is a long cylindrical portion, then in the middle about fifteen swollen cells, one of which is wider and more flattened than the others, functioning as the auxiliary cell, and above this a long and generally two or three times dichotomous sterile portion. This terminal sterile portion seems to drop off, or separate, about, or possibly even before, conjugation. *Dudresnaya australis* is plainly monoecious, the antheridia being very similar to those of *D. coccinea* as figured in Bornet and Thuret's *Notes Algologiques* (pl. xi, fig. 2).

Both tetrasporic and cystocarpic plants are represented among the plants at Lund and at London. The tetrasporangia are zonate, as are those of *D. coccinea*, the only other species of the genus in which they have as yet been found.

It is with some hesitation that I take this name of J. G. Agardh and publish it after his death. He had evidently refrained from publishing it, but I think that, had he been able to go over the recent additions to the genus and to have compared the various species that we now know, his judgment would have been to publish his *D. australis*. In examining the Schmitz collection of slides in the British Museum of Natural History, I find two of *D. australis*, but Schmitz made no mention of this species of the Southern Hemisphere in his account of *Dudresnaya* in the *Pflanzenfamilien*.

***Calosiphonia verticillifera* (J. Ag.) comb. nov.**

Helminthiopsis verticillifera J. G. Agardh, *Analecta Algologica*, cont. v, p. 98, 1899.

Plant single, or few together, from a discoid(?) base, rising up to 25 or 30 cm. in height, bushy, more or less broadly pyramidal in general outline, rose red, moderately gelatinous, with occasionally small and scattered deposits of lime; main axis more or less distinct, at times becoming indistinct above or losing itself in several main branches, slightly above the base, all of which are nearly equal in growth; axis and main branches slightly to strongly flattened below and distichously pinnately branched from the margins in the lower part, but becoming polystichous above, especially near the tips; branches of three to four orders, slightly attenuated towards each end, those of the last order fusiform; tetrasporangia unknown as yet; antheridia and cystocarps apparently on different plants; antheridia scattered over the entire surface of the antheridial plant which is paler in color than the cystocarpic; cystocarps minute, 35–45 μ in diameter, ellipsoidal, of few (12–15) spores, embedded in a transparent jelly which extends out on all sides beyond the spores, with a short cylindrical cell as a pedicel, loosely and irregularly scattered through the inner cortex, each beneath a minute carpostome.

Tortugas, *Mrs. Curtiss!*; Coopers Island, Bermuda, *W. G. Farlow!*.

The *Helminthiopsis verticillifera* of J. G. Agardh is one of the most beautiful of the Red Algae, and as J. G. Agardh says

(*loc. cit.*), it resembles in color and general appearance some of the forms of *Halymenia Floresia* (pl. 28, fig. 10). In structure, however, it is entirely different. The frond develops from a nearly hemispherical apical cell, from which cells are cut off by successive horizontal partitions. Vertically oblique walls, in turn, cut off four lateral cells from one of the subapical cells, and these in turn develop into a whorl of four ramelli, 3-4-chotomous below and dichotomous above. The resulting plant has a monosiphonous axis giving off successive whorls of ramelli whose ultimate segments combine to form a sort of cortex. The structure is very similar to that of *Calosiphonia Finisterrae* as represented by Bornet and Thuret in the *Notes Algologiques* (cf. pl. xii, figs. 1-3).

What seem to be antheridial plants differ from the cystocarpic only in being lighter colored. The antheridia are scattered more or less, uniformly over the surface, being borne singly or in pairs at the tips of the peripheral filaments. The antheridia are nearly globular and colorless.

The procarps and auxiliary cells were not seen. The cystocarps occur irregularly scattered and just under the periphery. They are very small and ellipsoidal and surrounding a thick layer of transparent jelly. Each cystocarp is supported on a short cylindrical cell and lies in a pear-shaped cavity which opens outward through the cortex by a small pore.

The type of the genus *Helminthiopsis*, as distinctly stated by J. G. Agardh, is *H. verticillifera*. But this species seems to fulfill all the proper requirements to be admitted to the genus *Calosiphonia*. If this view is correct, as it seems to me to be, the genus *Helminthiopsis* falls and is to be deleted. However, J. G. Agardh described a second species (*loc. cit.*, p. 98), founded upon an Australian plant, which he named *H. (?) rosea*.

The type of *H. (?) rosea* is a single specimen, no. 31989 of Herb. J. Agardh at Lund. It was collected at Port Phillip Heads, Victoria, Australia, by J. Bracebridge Wilson on January 23, 1886. It is extraordinarily unlike *H. verticillifera*, both in habit and structure. It is a very small plant of a rosy red color, having a central strand of slender vertical filaments which give off horizontal moniliform ramelli. The cystocarps are small

with a circle of overarching bracteoid filaments. I have not made a sufficiently careful study to speak with certainty, but it seemed to me, while examining it, to be a species of *Helminthocladia*, in all probability.

BAYLESIA, gen. nov. Dumontiacearum

Frons anceps, e disco radicali erecta; axe principali elongata, pauciramosa, ramis elongatis, axe ramisque pinnis brevibus distiche et conferte ramulosis plumosis vestientibus; axe principali, ramis, ramulisque a cellula apicali orientibus e qua axibus monosiphoneis, ramellis peripheralibus verticilliter positis, et filamentis descendantibus orientibus; tetrasporangiis antheridiisque adhuc ignotis; procarpiis et cellulis auxiliaribus in ramellis propriis curvatisque positis; cystocarpis reniformibus, integris aut lente sublobatis, pedicellis curvatis suffultis.

Genus ad Pikeam vergens, sed per ramulos fertiles non tumefacientes distinguendum et in honorem Dominarum Bayles nominatum.

B. plumosa, sp. nov.

B. fronde solitaria (?), e disco radicali, ancipite, elongata, vinoso-rubra, erecta, ad 60 cm. alta, parce ramosa, ubique distiche pinnato-plumosa, ramis paucis elongatis, conformibus, ramulis plumosis, numerosis margines axis ramorumque dense vestientibus, ipsis curtis dense et distiche ramulosis; cystocarpus in ramulis non tumefacientibus.

Infrequens, rejecta ab undis, prope "Monterey" in ditione Californiensi, ubi detexerunt Dominae A. et A. Bayles, Domina J. M. Weeks, Doctor C. L. Anderson, et W. A. Setchell.

For many years there has been great confusion in the plants placed under the name of *Pikea californica* Harv.,—in fact, Harvey himself founded the species upon two different plants at least. One, however, seems to stand out as the type and that is the plant distributed under no. 897 of the *Phycotheca Boreali-Americana*. Harvey, however, evidently founded his species partly on the plant we now call *Farlouia mollis*. *Pikea pinnata* has also been confused under *P. californica* as have been several other plants, one of which is the plant just described.

Baylesia plumosa seems to be a rare plant, having been found only a few times and then only cast up by the waves. It has been detected thus far only on the shores of Monterey Bay, or immediate vicinity. The attachment is wanting in all but one

of the specimens I have seen. *Baylesia* is to be distinguished from all the Dumontiaceae closely related to *Pikea*, by the extreme differentiation between the long and the short axes, which gives the plant its particularly plumose appearance. This serves to distinguish it from *Leptocladia* J. Ag. (= *Andersoniella* Schmitz) and *Farlowia*, while from *Pikea* itself it is to be farther separated by the fact that the branchlets containing the cystocarps are not at all swollen. The internal structure resembles that of *Cryptosiphonia* and of *Pikea*. The auxiliary cells are in specialized curved branchlets characteristic of the Dumontiaceae.

I take great pleasure in dedicating the genus created for the reception of this beautiful and rare plant to the Misses A. and A. Bayles of Pacific Grove, California, who have been zealous in their search after rare and beautiful specimens of marine algae and who have always been willing to share with me their choice specimens. I am indebted to them for a fine fruiting specimen of the *Baylesia plumosa*. This is regarded by me as the type and is no. 95043 Herb. University of California. Another specimen (no. 95045 Herb. Univ. Calif.) has been chosen for photographing and representation on plate 29, figure 11, since it is less dense and more suitable for reproduction by photography. I have also been allowed to examine and affix a manuscript name to specimens of *Baylesia plumosa* in Herb. Farlow at Harvard University and in the Herbarium of the New York Botanical Garden. In both cases the specimens were collected on the shores of Monterey Bay, California, by Dr. C. L. Anderson.

***Leptocladia Binghamiae* J. Ag.**

The genus *Leptocladia* was described by J. G. Agardh in 1892 (*Analecta algologica*, *Acta. Soc. Physiogr. Lund*, vol. 38, p. 95) from a plant collected at Santa Barbara, California, presumably by Mrs. Bingham. The type and only species, viz., *Leptocladia Binghamiae* J. Ag., is represented by two fragments in Herb. J. G. Agardh at Lund, preserved under no. 28231. They are both cystocarpic. Although neither specimen is in any fashion complete, yet they are both sufficiently perfect and characteristic to be identified with certainty with the plant distributed under no. 700 of the *Phycotheca Boreali-Americana* as *Andersoniella Farlowii* Schmitz.

Leptocladia Binghamiae is well described and in considerable detail by J. G. Agardh, who lays stress upon a number of characteristic points. He was, however, in very considerable doubt as to the systematic position of the plant but placed it for the time being in his Rhodymenieae, comparing it particularly with *Hymenocladia* and *Plocamium*. De Toni (*Syll. Alg.*, iv, 2, p. 609, 1900) places it in the Family Rhodymeniaceae and the Subfamily Plocamiaceae. Schmitz does not mention the genus at all in his account of the Rhodophyceae in the *Pflanzenfamilien*. From its possession of specialized curved auxiliary ramelli in the fertile portions of the frond, *Leptocladia Binghamiae* seems to belong to the Dumontiaceae, as now limited, and in the immediate vicinity of *Pikea*, under species of which it may, at times, be found in different herbaria. It may be distinguished from species of that genus (as limited by Schmitz) by having the cystocarps scattered through the upper and not specially swollen or otherwise differentiated portions of the fertile plants. There are other characters, viz: the subdichotomous branching, and the details of structure and development of the cystocarp which distinguish it from the species of *Farlowia*, while it is to be readily separated from species of *Cryptosiphonia* by its complanate and distichously subdichotomous frond.

Andersoniella Farlowii Schmitz is briefly described by him in Engler & Prantl's *Pflanzenfamilien* (1 Th., Abth. 2, p. 520, 1897). The type of Schmitz can be located only by inference. It is, I feel certain, represented by four slides in the Schmitz collection at the British Museum of Natural History, numbered 4.86. The slides purport to have been prepared from no. 28 of Farlow, Anderson and Eaton's *Algae Exsiccatae Americae Borealis*. This number was probably supplied by Dr. C. L. Anderson to Grunow, who, in turn, loaned it to Schmitz. No. 28 of the *Alg. Exs. Am. Bor.* is labelled *Farlowia compressa*, but an examination of different copies shows that the specimens were mixed. There were distributed under this number true *Farlowia compressa* (Herb. Farlow!, Herb. Brit. Mus. Nat. Hist., Herb. Univ. Calif.!) and undoubtedly this number was based on the proper plant, but *Andersoniella Farlowii* was also distributed (Herb. N. Y. Bot. Garden!) as well as an undescribed species of

Leptocladia (to be named *L. conferta* below) in one copy (Ex Herb. Asa Gray in Crypt. Herb. Harvard Univ.). It seems perfectly possible, then, that *Andersoniella Farlowii* may be found in other regularly issued copies of this distribution. Dr. Anderson also distributed duplicates from his collection with the printed labels of the *Alg. Exs. Am. Bor.*, and this has been a source of confusion in the case of certain numbers.

The four slides in the Schmitz collection, prepared from no. 28 of the *Alg. Exs. Am. Bor.*, represent the plant distributed under no. 700 of the *Phycotheca Boreali-Americana* mentioned above as being the *Leptocladia Binghamiae* of J. G. Agardh. They are not labelled *Andersoniella* by Schmitz, but "*Farlowiella*." They agree, however, with Schmitz's description of his *Andersoniella Farlowii* and it seems extremely probable that Schmitz, finding *Farlowiella* preoccupied, changed the name in his manuscript, without changing the designation on his slides.

The name for the Californian plant must be *Leptocladia Binghamiae* J. Ag., and it seems as certain as may be made possible that the later *Andersoniella Farlowii* Schmitz is the same plant. It is not uncommon on the coast of Southern California (San Diego, Mrs. M. S. Snyder!, Will S. Wright!, H. Hemphill!, Miss Minnie Reed!; San Pedro, A. J. McClatchie!, Mrs. S. C. Purdy!, W. A. Setchell!; Ventura, Mr. Tenney!; Santa Barbara, Mrs. Bingham, Dr. and Mrs. L. N. Dimmick!); and it extends up to Santa Cruz (Dr. C. L. Anderson!, Dr. W. G. Farlow!). Both cystocarpic and tetrasporic plants have been found.

***Leptocladia conferta* sp. nov.**

L. fronde gregaria, erecta, e disco radicali, 15-20 cm. alta, atro-rubra, cartilaginea, angusta, complanata, crassa, subdichotomo—ramosa, ramis elongatis ubique ramulis proliferis confertis et fasciculatis apud margines obsitis, obsolete serratis fimbriatisque; strato medullari filamentum monosiphonium crassumque centrale et filamenta descendunt tenuiaque numerosissima ostendente strato corticali filamenta radiantia 2-4-chotomo-ramosa cellularum tenuiorum intus majorum extusque minorum ostendente; tetrasporangiis antheridiisque adhuc ignotis; ramellis auxiliaribus curvatis, e cellulis paucis discoideisque compositis; cystocarpis immersis, ubique in ramis superioribus non tumefacientibus, reniformibus, profunde paucilobatis, inferne pedicellis curvatis curtisque suppositis; sporis

in filamentis 2-3-chotomo-ramosis, e cellulis basalibus paucis pallidioribusque radiantibus; carpostomio, ut videtur, nullo.

Hab. in saxis apud oras Californienses meridionales.

Under the name proposed above, I have placed plants which I have observed most carefully at a locality locally known as "Dillon's Beach," situated on the coast of California just north of the mouth of Tomales Bay. I have also collected others at Carmel Bay, near Monterey, California. The species has been collected at Santa Cruz (or Pacific Grove?), California, by Dr. C. L. Anderson and appears in some copies of Farlow, Anderson and Eaton's *Algae Exsiccatae Americae Borealis*, as mentioned above. I have also received specimens from as far north on the California coast as Trinidad Head, whence they were sent by Mr. C. M. Drake. Thus far, then, it seems to be a plant of the middle California coast. *Leptocladia conferta* grows in rather bushy tufts which are dark red and rigid, where shallow pools are left by the receding tide in the lower portion of the littoral zone.

One characteristic feature of this species is the abundance of the fasciculate proliferations. I have visited the locality at Dillon's Beach during most of the seasons of the year and have never, as yet, found any really young plants. All seem older and have few to very many of the characteristic proliferations which give the species its bushy appearance. The specimens are fairly constantly cystocarpic and, although I have had the opportunity of examining several hundred plants, I have found no indication of either tetrasporic or antheridial individuals.

Leptocladia conferta has the complanate frond and the sub-dichotomous normal branching of *L. Binghamiac*, but the frond of the former is narrower and thicker than that of the latter, less prominently serrate, more cartilaginous, and constantly and, as it seems, characteristically beset with the longer or shorter adventitious proliferations. This habit is well shown in figure 12 of plate 30. The microscopic structure of the two species is very similar, as it is also to that of *Pikea*, differing only in minor details. The cystocarps, too, are very similar in the two species, but in *L. Binghamiac* there is a carpostome present, while there does not appear to be such a structure in *L. conferta*. They both

agree, however, in having the cystocarps scattered through the upper, not swollen or otherwise modified, portions of the frond.

***Weeksia Fryeana* sp. nov.**

W. fronde ampla, membranacea, late aut anguste reniformi, integre aut parce lobata laciniatave, 30–35 cm. alta, 15–30 cm. lata, roseo- ad purpureo-rubra, marginibus integris, varie et late lobatis, e disco radicali, ut videtur, emergente, stipite obsolete; f. stratis tribus contexta, strato medullari lato, filamentis crassis granulatisque intertextis, stratis duobus corticalibus intus cellulis majoribus depresso sphericis hyalinisque, extus cellulis parvis coloratisque in seriebus anticlinis curtisque constitutis et cuticula hyalina indutis; tetrasporangiis in cortice immersis, triangulo-divisis; antheridiis(?) superficialibus, effusis, pallidis, in plantis propriis(?); ramellis procarpiiferis elongatis lente curvatisque serie cellularum basi depresso-sphericarum apice tumidarum et unilaterale elongatarum compositis, cellula apicali late conica in pilum longum desinente; ramellis auxiliaribus conformibus sed cellula apicali depresso-spherica; cystocarpiis per stratum corticale dispersis, majoribus, rotundatis, pedicellatis filamentis ooblastematicis e cellulis centralibus radiantibus, ramosis, basi decoloratis, apice laete rubris et in sporis catenatis transformatis; carpostomio inconspicuo, sed, ut videtur, adente.

Rejecta ab undis et in aquis 40 m. in profundo, apud insulas dictas "Orcas" et "San Juan," in ditone Washingtoniensi, ubi detexerunt Prof. T. C. Frye et Dr. N. L. Gardner.

In 1904 there was dredged, presumably in twenty fathoms of water, off Newhall, on Orcas Island, Washington, a small specimen which was sent to me for identification by Professor T. C. Frye of the University of Washington. The plant appeared possibly, but not altogether certainly, to be antheridial. Later a much finer and more perfect plant was sent by Professor Frye, collected at Deer Harbor on San Juan Island, in the same State. This plant has cystocarps and thus it is possible to make certain that it is a member of the Dumontiaceae and constitutes a second and a new species of the genus *Weeksia*.

Weeksia Fryeana is a large plant; probably it will be found to be a very large plant for a red alga, and may have been collected previously under the impression that it belonged to *Schizymenia* or to *Sarcophyllis*. It is to be distinguished from all species of the former genus by its cystocarpic structure and

development and from all known species of the latter by its habit, more delicate texture, and certain structural details of the procarps and cystocarps.

Like *Weeksia reticulata*, *W. Fryeana* is of a fleshy consistency and of a light rosy red color very similar to that of *Callymenia reniformis*. Both species of *Weeksia* have the reniform habit of *Callymenia*, especially in older and characteristic forms. *W. reticulata* proliferates from the margin, the proliferations being in turn Callymenoid, but thus far no such process has been seen in *W. Fryeana*. However, as stated above, only a very few specimens and fragments of *W. Fryeana* have been seen. In neither of the species of *Weeksia* are the surfaces smooth and even, both being indefinitely wavy and uneven. In *W. reticulata*, however, as its name indicates, there is a series of broad but obscure veins radiating from the base and forming a coarse reticulation through the middle region of the frond, and vanishing towards the margins. Nothing like this has been seen in *W. Fryeana*.

The few specimens thus seen have come from Orcas Island (T. C. Frye!, N. L. Gardner!), where they have been obtained from deep water. I have also seen and, through the courtesy of Dr. M. A. Howe, have been able to examine a specimen of very considerable interest in the Herbarium of the New York Botanical Garden. It is a specimen with the label-heading: "Herbarium of the U. S. South Pacific Exploring Expedition under the command of Capt. Wilkes, U. S. N., 1838-1842." It is identified as "*Iridaea Mertensiana*," and was collected somewhere in "Oregon and Washington Territory." The fragment examined shows young procarps and auxiliary branchlets.

Transmitted January 22, 1912.

EXPLANATION OF PLATES

PLATE 25

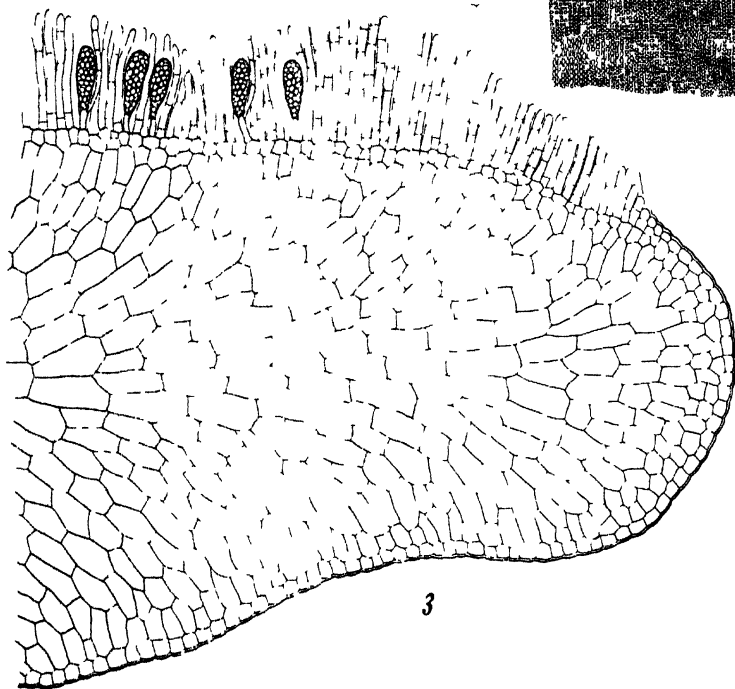
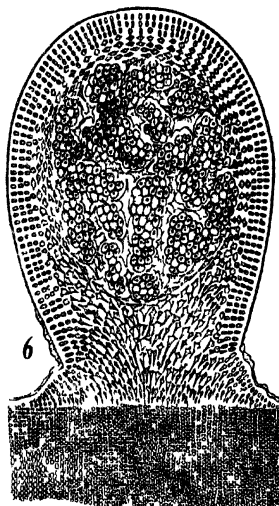
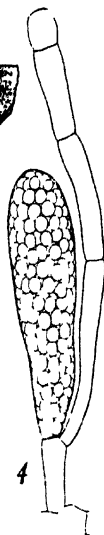
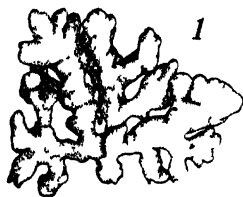
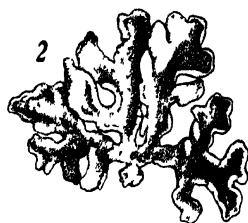
Hapterophycus canaliculatus Setchell & Gardner

1. Portion of a thallus seen from the upper side. $\times 2$ diam.
2. Portion of a thallus seen from the lower side. $\times 2$ diam.
3. Vertical section through a lobe of the thallus, showing a portion of a sorus above. $\times 280$ diam.
4. Unilocular sporangium and paraphysis. $\times 920$ diam.

Besa papillaeformis Setchell

5. Portion of the crustaceous thallus of the host, bearing four plants of the hemiparasite. $\times 60$ diam.
6. Median vertical section through a cystocarpic plant and a portion of its host. $\times 240$ diam.

Figures 1-4 were drawn under the writer's direction by Miss Anna Hamilton, and figures 5 and 6, by Mr. W. C. Twiss.



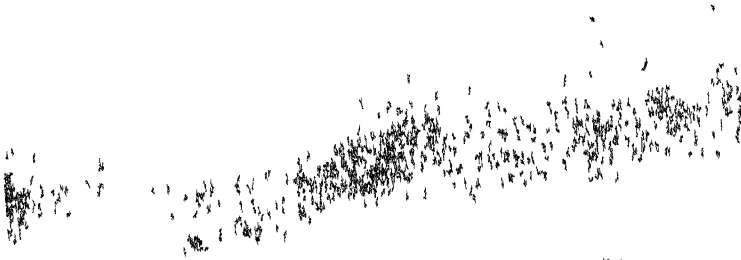


PLATE 26

Area (I)

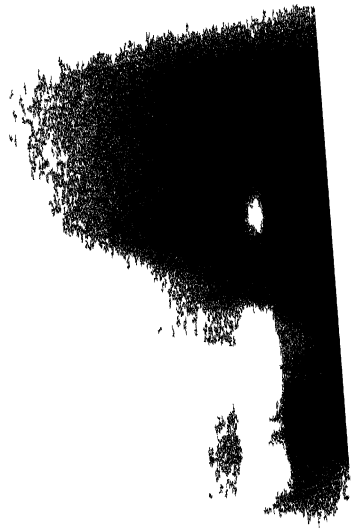




PLATE 26

Dudresnaya caribaea (J. Ag.) Setchell

8. Habit of the type specimen. $\times 1$ diam
Photograph, through the kindness of Mr M B Nichols.

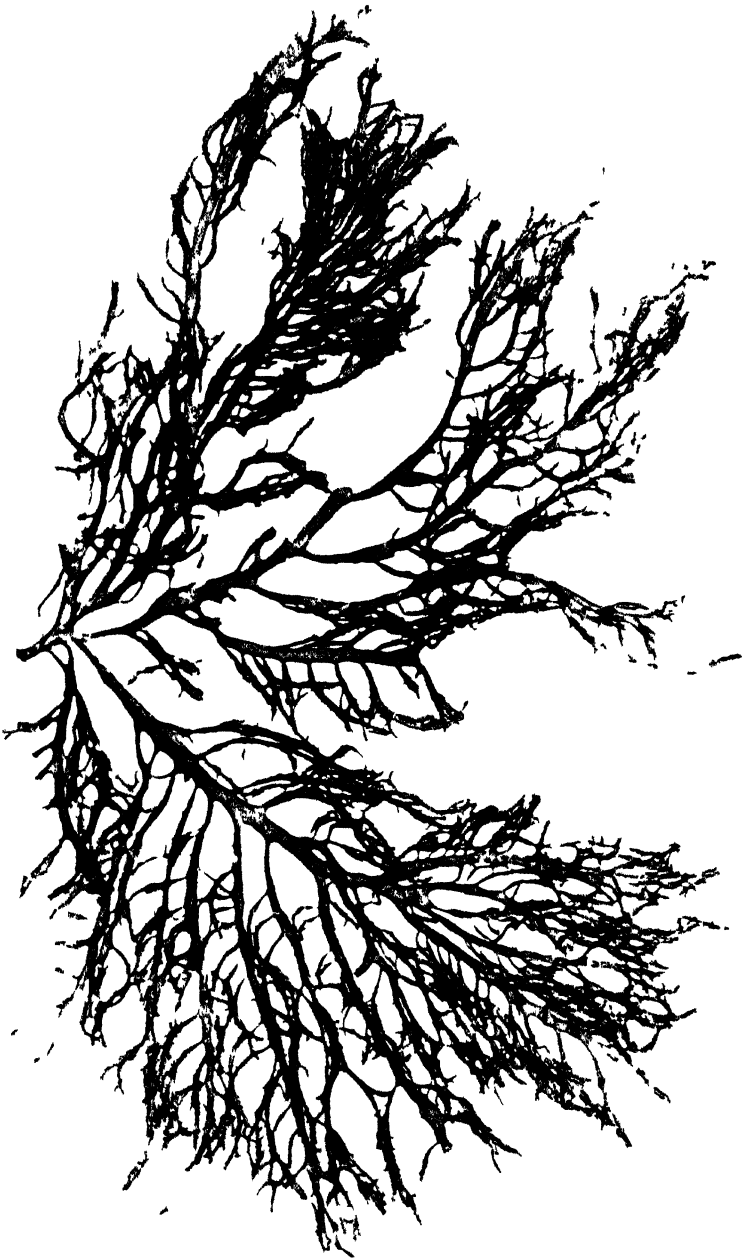


PLATE 27

Dudresnaya bermudensis Setchell

5. Habit of the type specimen. $\times \frac{1\frac{3}{8}}{1}$ diam.

Photograph, through the kindness of Mr. M. B. Nichols.

Dudresnaya australis J. Ag.

9. Habit of a cotype in the J. Bracebridge Wilson collection in the British Museum of Natural History. $\times \frac{1\frac{2}{3}}{1}$ diam.

Photograph, through the courtesy of Mr. A. Gepp.



8



PLATE 28

Calosiphonia verticillifera (J. Ag.) Setchell

10 Habit of a specimen, collected by Dr. W. G. Farlow at Coopers Island, Bermuda, in 1881 $\times \frac{125}{157}$ diam.

Photograph, through the kindness of Mr M. B. Nichols.

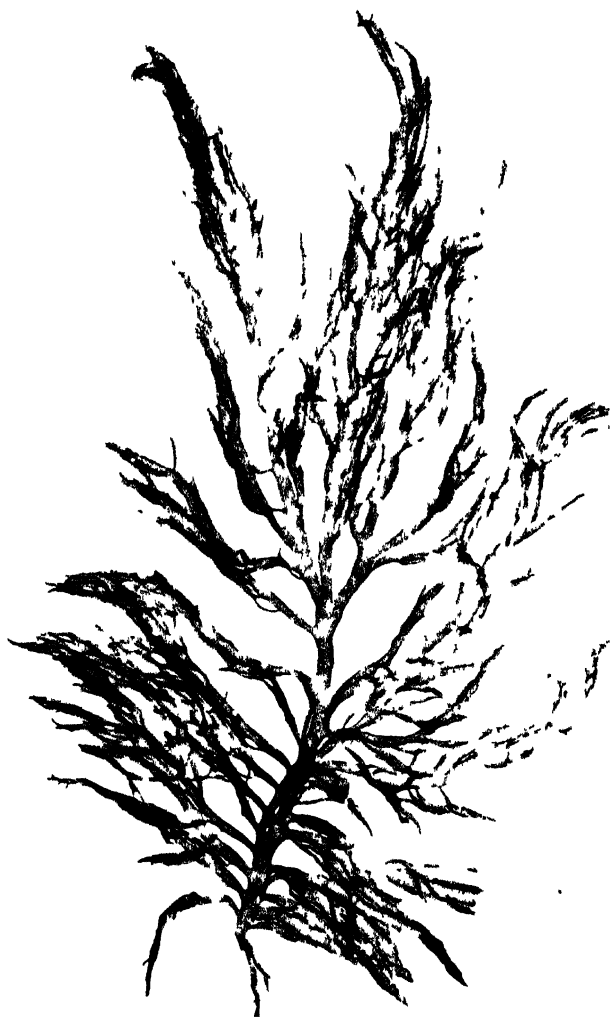


PLATE 29

Baylesia plumosa Setchell

11. Habit of a typical plant, collected at Pacific Grove, California, by
W. A. Setchell. $\times \frac{22}{87}$ diam.

Photograph, through the kindness of Mr. M. B. Nichols.

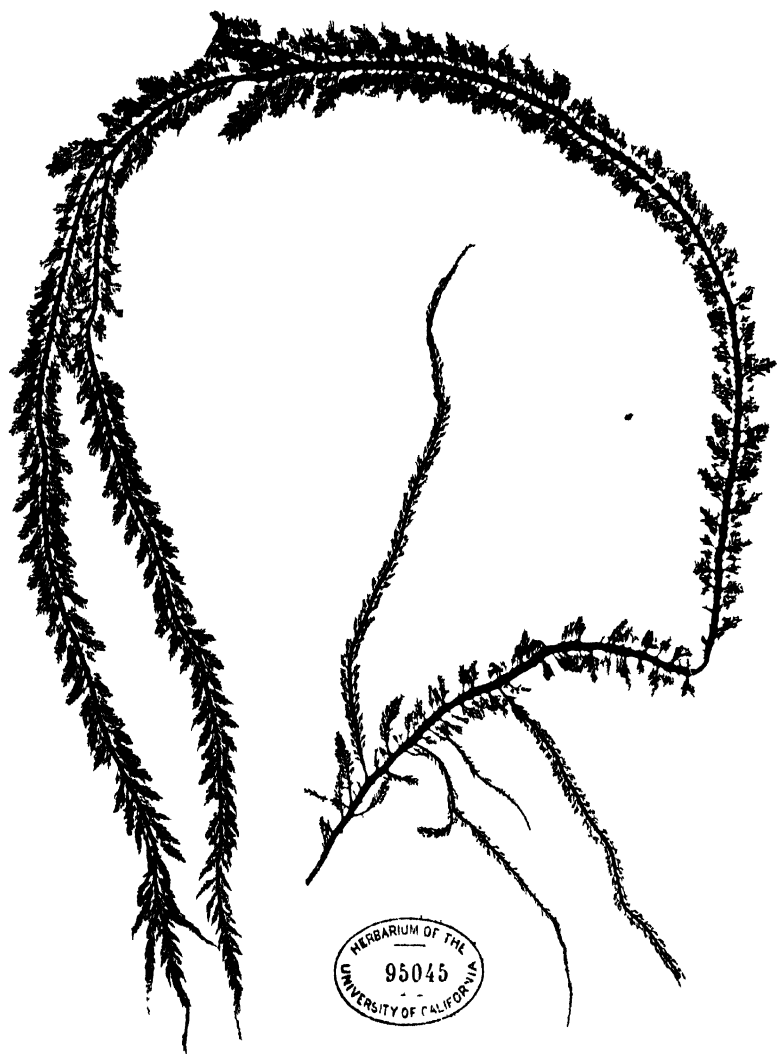


PLATE 30

Leptocladia conferta Setchell

12. Habit of a typical plant, collected at Dillon's Beach, Marin County, California, by W. A. Setchell. $\times \frac{25}{89}$ diam.

Photograph, through the kindness of Mr. M. B. Nichols.



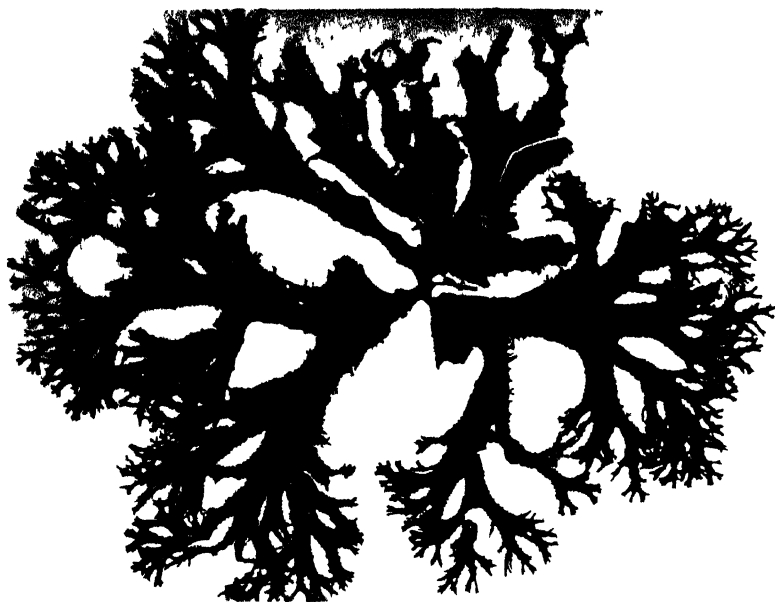
PLATE 31

Faucheia Fryeana Setchell

13. Habit of cystocarpic type specimen. $\times \frac{4}{18}$ diam.

14. Habit of tetrasporic plant somewhat younger than the type specimen, but a cotype. $\times \frac{2\frac{3}{8}}{8}$ diam.

Photographs, through the kindness of Mr. M. B. Nichols.



PLANTAE MEXICANAE PURPUSIANAE, IV

BY

TOWNSHEND STITH BRANDEGEE

Dr. Purpus during the last year made large collections of plants in the State of San Luis Potosi at Rascon and Minas de San Rafael. Rascon is a locality of much lower altitude than Minas de San Rafael and consequently has quite a different flora. Some few plants were also collected in Puebla and at Pedregal near the city of Mexico.

The following descriptions are those of plants which seem to have been hitherto unknown.

***Tradescantia collina* sp. nov.**

Caulis basi geniculatus glaber; foliis anguste ovato-lanceolatis, margine minute scabro-serrulatis, 1 dm. longis, 1.8 cm. latis, vagina ca. 7 mm. longa, ore barbata; pedunculis ramos terminantibus, ca. 13 cm. longis; pedicellis 2-3 cm. longis umbellatis, basi bracteatis, bracteis lanceolatis 4 mm. longis; umbellulis 4-8-floris, floribus sessilibus vel pedicellis usque ad 1 cm. longis, bracteis parvis scariosis late ovatis; sepalis viridibus, margine albis, apice interdum pilosis; petalis roseis sepalis aequantibus; staminibus 6 aequalibus; filamentis nisi juxta apices longe denseque barbatis; antherae loculis basi disjunctis cum connectivo triangulari; stylo quam petalis longiore; seminibus 3(?) rugosis.

The umbel is about 8-rayed and its scarious bracts are sometimes subtended by two additional small leaf-like opposite ones. The single capsule available contained but three seeds and a few abortive ovules. Collected near Minas de San Rafael. No. 5400. Type, Herb. Univ. Calif., No. 155199.

Boerhaavia ciliata sp. nov.

E radice lignosa multicaulis; caulibus ascendentibus, hirsutis cum pilis glanduliferis simul puberulis; foliis late ovatis fere orbicularibus, basi cordatis vel rotundatis, apice obtusis saepe mucronatis, supra flavo viridibus, glabris, subtus, pallidioribus, ad venas hirsutis, margine ciliatis, ca. 1.5 cm. longis, 1.3 cm. latis; petiolis hirsutis ca. 6 mm. longis; floribus paniculatis, pedunculis 1–2 cm. longis, pedicellis brevibus; corolla purpurea; staminibus 4 paululum exsertis; fructu immaturo oblongo, apice rotundato, late 5-costato, 4–5 mm. longo, glabro.

The long penducles bear usually a single flower, but are sometimes umbellately 3-flowered. Collected near Minas de San Rafael. No. 5288. Type, Herb. Univ. Calif., No. 155267.

Philadelphus Purpusii sp. nov.

Ramis brunneis hirsuto-pubescentibus; foliis ovatis, apice mucronatis, margine integris, utrinque hirsuto-strigosis, subtus cum pilis longioribus, ca. 1 cm. latis, 1.5 cm. longis; petiolis ca. 3 mm. longis hirsuto-strigosis; calyce extus albo-hirsuto pubescente, lobis acuminatis; corolla diametro 2.5 cm.; stylis liberis ovario apice piloso.

This species is nearest *P. Coulteri* Wats. but from Pringle's specimen (No. 10174) so named it differs in the shape of the leaves and the pubescence. Collected near Minas de San Rafael. No. 5368. Type, Herb. Univ. Calif., No. 155233.

OXYRHYNCHUS gen. nov. Leguminosarum

Calyces campanulati, lobi obtusi subaequales. Vexillum orbiculatum complicatum, carinam includens, basi auriculis appendiculatum; alae falcato-obovatae carinae adhaerentes; carina valde rostrata, non spiralis. Stamen vexillare liberum, cetera usque ad medium connata; antherae uniformes versatiles. Ovarium subsessile 2–3-ovulatum; stylus apice capitatus penicillatus, parte superiore barbata. Legumen oblongum compressum coriaceum suturis incrassatis densissime fusco-hirsutum. Herba volubilis, foliis pinnatim 3-foliolatis stipellatis. Flores flavo-virides in racemis axillaribus fasciculati, fasciculorum rhachi inconspicua. Bractae et bracteolae striatae parvae.

Oxyrhynchus volubilis sp. nov.

Foliolis ovato-acuminatis papyraceis mucronatis, supra glabris, subtus parce hirsutis, lateralibus basi valde inaequilateralibus, usque ad 4 cm. longis, 2.8 cm. latis, breviter petiolatis, terminali majore stipulis lanceolatis 4 mm. longis; pedunculis ca. 2.5 cm. longis; calycis lobis tubum aequantibus orbiculatis ciliatis; legumine oblongo, ca. 3 cm. longo, 1.5 cm. lato, apice mucronato, 2-3-spermo.

This plant has the aspect of *Phaseolus*, the rostrate keel of *Dolicholus*, with the legume and ovular attachment of *Eriosema*. Collected near Rascon. No. 5281. Type, Herb. Univ. Calif., No. 155222.

Phaseolus Purpusii sp. nov.

Caulibus e radice lignosa fere glabris prostratis vel volubilibus; foliis trifoliolatis saepissime glabris; foliolo terminali oblongo-lineari, 2-7 cm. longo, 3 mm. lato, acuto vel obtuso mucronatoque, 1-nervio, reticulato, basi obtuso; foliolis lateralibus alte bilobatis, lobis oblongo-linearibus, 1-3 cm. longis, acuminatis; stipulis oblongo-ovatis parvis; racemis quam foliis duplo longioribus paucifloris; pedicellis ca. 1 cm. longis; calycis dentibus late deltoideis; alis purpureis obovatis, 1 cm. longis, quam carina flava vexilloque longioribus; leguminibus falcatis, 2-3 cm. longis, 15 mm. latis.

Collected near Minas de San Rafael. No. 5196. Type, Herb. Univ. Calif., No. 149841.

Erythrina petraea Brandeg.

Zot., v. 247

The fruit of this plant was unknown when the species was described, but it has since been obtained by Dr. Purpus, and young plants are now growing in the Botanical Garden of the University.

The legumes are 4-8 cm. long, subterete, acute at both ends, 1-2-seeded, when 2-seeded strongly constricted in the middle. The seeds are dark brown. In the better known species they are bright red as the name implies.

Brongniartia discolor sp. nov.

Frutex, ramis juvenilibus adpresse sericeis; foliis ca. 10 cm. longis; foliolis 17–25, oblongo-ovatis 10–15 mm. longis, supra pubescentibus viridibus subtus albo-sericeis, acuminatis cum mucrone sericeo-tomentosi; stipulis foliolis similibus; floribus 1–4 axillaribus, pedunculis ca. 2 cm. longis; bracteis ovato-lanceolatis, ciliatis; calycis dentibus tribus lanceolatis, uno ovato-lanceolato, fere glabris; legumine 3.5 cm. longo, 1.3 cm. lato, glabro 4-spermo, mucronato.

Some of the more glabrous specimens appear to vary towards *B. foliolosa* Benth. Collected at Bagre, San Luis Potosi. No. 5201. Type, Herb. Univ. Calif., No. 149842.

Tephrosia potosina sp. nov.

Ramosa decumbens, basi frutescens, caulibus pubescentibus; foliis usque ad 14 cm. longis, petiolos pubescentes 6 cm. longos includentibus; foliolis 3–7, petiolulatis orbicularibus, basi rotundatis vel cuneatis, ca. 3 cm. longis, 2.8 cm. latis, supra glabris, subtus sericeo-pubescentibus venosisque, apice obtusis vel retusis. mucronulatis; stipulis lineari-lanceolatis, striatis hirsutis, 8 mm. longis; racemis 2 dm. longis, ca. 12-floris; pedicellis 5 mm. longis; calyce dense hirsuto, lobis ovato-lanceolatis, 3 mm. longis, quam tubo longioribus, 2 superioribus alte connatis; vexillo extus sericeo-hirsuto, viride deinde purpurascens; leguminibus juvenibus dense flavo-hirsutis acuminatis.

Collected near Rascon. No. 5273. Type, Herb. Univ. Calif., No. 155269.

Polygala nitida sp. nov.

Caules lignosi puberuli decumbens ca. 1 m. longi, foliis oblongo-ovatis acuminatis glabris, basi cuneatis, supra nitentibus, ca. 2 cm. longis, 6 mm. latis venosis; petiolis 1 mm. longis; racemis axillaribus paucifloris; floribus roseis; pedicellis 2 mm. longis, patentibus; sepalis anticis petaloideis, ovato-lanceolatis quam sepalo superiore minoribus; alis obovatis, 6 mm. longis, 3 mm. latis, quam carina longioribus; petalis superioribus oblongo-lanceolatis; carina per $\frac{2}{3}$ cum tubo staminali connata; crista petalis superioribus fere aequante erecta; capsulis oblongo-obovatis, emarginatis, glabris, venosis; semine piloso, arillo in appendiculas duas prolongato.

This species belongs to § *Chimaebuxus* and is related to *P. cornuta* Kell. and *P. Californica* Nutt. Collected near Bagre, San Luis Potosi. No. 5168. Type, Herb. Univ. Calif., No. 149877.

***Polygala (Hebecarpa) tehuacana* sp. nov.**

Pubescens, multicaulis e radice lignosa, caulibus strictis ca. 1 dm. altis; radicibus cum rhizomatibus subterraneis conjunctis; foliis ovato-lanceolatis, sessilibus, 6 mm. longis, 2 mm. latis; flore saepissime solitario caulem terminante, purpureo-flavescente; alis late obovatis, purpureo-venosis, 5 mm. longis, 4 mm. latis, quam petalis superioribus carinaque longioribus; petalis superioribus anguste alata; seminibus pyriformibus pilis adpressis vestitis; 6 mm. longa fere orbiculari, apice emarginata, margine ciliata, anguste alata; seminibus pyriformibus pilis adpressis vestitis; arillo capitellato, appendice brevi margine lacerata.

Mountains west of Tehuacan, Puebla. No. 5706. Type, Herb. Univ. Calif., No. 155260.

Polygala macradenia Gray, should have been the name given to No. 4913 distributed as *P. glandulosa* HBK. True *P. glandulosa* has since been collected on Sierra de Guascama. No. 5166.

***Argithamnia argentea* sp. nov.**

Frutescens, ca. 3 dm. alta ramosa, caulibus albescentibus glabris, juvenibus sericeo-pubescentibus; foliis ovato-acuminatis, margine integris, basi cuneatis, indistincte 5-nervis, supra parce sericeo-pubescentibus, subtus dense albo-sericeo-pubescentibus, ca. 2 cm. latis, 4–5 cm. longis, petiolis brevibus; racemis 1–8-floris quam foliis brevioribus; floribus masculis superioribus, pedicellis 2–5 mm. longis; calycis segmentis ovato-lanceolatis sericeo-pubescentibus quam petalis roseis spathulato-acuminatis longioribus; staminibus 10, usque ad medium et ultra connatis; glandulis liberis; flore femineo longiuscule pedicellato, petalis 0, disco cum processibus brevibus glandulis oppositis instructis; ovario glabro; stylis ad medium connatis apice bifidis; stigmate minute laciniato. Fructus maturus deest.

In general appearance this plant resembles *A. Pringlei* Greenm. The appendages to the disk of the female flower, on account of their position can hardly be taken as representing petals. Collected near Minas de San Rafael. No. 5459. Type, Herb. Univ. Calif., No. 155263.

***Buxus lancifolia* sp. nov.**

Frutex glaber, ramis tetragonis, angulis paulo alatis, saepe subereis; foliis nitentibus ovato-lanceolatis, sessilibus, basi attenuatis, margine revolutis, ca. 6 cm. longis, 1.6 cm. latis, nervis

secundariis prope marginem connexis; inflorescentia axillari capitato-racemiformi, breviter pedunculata; floribus masculis pedicellatis, calycis segmentis ovato-lanceolatis, ciliatis, 2 mm. longis, pedicellis aequantibus; staminibus exsertis; flore femineo sessili, calycis segmentis mari similibus, stylis inter se distantibus, apice recurvatis, quam ovario longioribus; seminibus atris nitentibus.

From the description this species must be near *B. Purdieana* Baill., from Jamaica, but in addition to other differences *B. lancifolia* appears to have smaller leaves with revolute margins and inconspicuous veins. Collected along Rio de las Gallinos near Rascon. No. 5308. Type, Herb. Univ. Calif., No. 155266.

Rhamnus Purpusii sp. nov.

Arbor parva glabra, ramulis brunneis; foliis alternantibus oblongo-ovatis, penniveniis, papyraceis, nitentibus, apice obtusis, basi interdum cuneatis, margine integris, ca. 7 cm. longis, 2.8 cm. latis; petiolis ca. 5 mm. longis; floribus in cymulis axillaribus paucifloris, pedunculis quam petiolis brevioribus, pedicellis ca. 5 mm. longis; calycis lobis deltoideis intus valde cristatis; petalis 0; ovario in disco lato immerso 2-loculari. Fructum non vidi.

A peculiar species with apetalous flowers and shining leaves. Collected near Minas de San Rafael. No. 5348. Type, Herb. Univ. Calif., No. 155265.

Trichilia Schiedeana A. H. var. **Purpusii** var. nov.

Foliolis brevioribus latioribusque.

This agrees with the description of the species in nearly all particulars, but the leaflets are shorter and broader and the leaves resemble those of *Melia Azedarach*. Dr. Purpus reports the variety as common about Rascon. No. 5322. Type, Herb. Univ. Calif., No. 155198.

Sida tehuacana sp. nov.

Suffrutescens, caulibus strictis purpureis, fere glabris; foliis deltoideo-acuminatis, acute serratis, basi cordatis, ca. 3.5 cm. longis, 1 cm. latis; petiolis 1-2 cm. longis; stipulis lanceolatis; pedunculis 1-4 cm. longis, cum ramulis brevibus paniculam bracteosam formantibus, vel axillaribus, unifloris, prope flores articulatis; petalis 8 mm. longis, laete purpureis, quam calyce duplo longioribus; calycis dentibus deltoideis carpellis aequantibus; carpellis 7, muticis, dorso bivalvibus.

This plant appears to be related to *S. Palmeri* Baker. It is nearly glabrous, the flowers very light purple. Collected at Tehuacan, Puebla. No. 5662. Type, Herb. Univ. Calif., No. 155249.

***Sphaeralcea? fruticosa* sp. nov.**

Frutex ramosus, cortice brunneo rugoso; foliis oblongis, basi cordatis apice obtusis, margine crenato-dentatis, utrinque dense minuteque stellato-pubescentibus, ca. 2.5 cm. longis, 1 cm. latis; petiolis stellato-pubescentibus, ca. 5 mm. longis; floribus singulatim axillaribus, pedicellis ca. 2.5 cm. longis, supra medium articulatis; calyce fere ad medium lobato, lobis deltoideis; bracteolis 0; corollae segmentis cuneatis, apice retusis, violaceis, 8 mm. longis; carpellis maturis ab axi secedentibus, apice inflexis ad medium constrictis, parte superiore vacua, 1-ovulatis, ovulo pendulo.

The petals are spreading and of a blue color. The calyx exceeds the obtuse carpels. When the carpel separates from the axis it is held for a time by a thread at the base. The walls of the carpels are rugose on the sides of the lower half and diaphanous in the upper. The leaves are velvety tomentose and pinnately veined. According to the notes of Dr. Purpus it is a small bush growing on rocks. Collected near Minas de San Rafael. No. 5382. Type, Herb. Univ. Calif., No. 155229.

***Fraxinus potosina* sp. nov.**

Glabra, foliis simplicibus orbicularibus crenato-dentatis, venosis, basi cordatis vel cuneatis, diametro usque ad 2.5 cm.; racemis abbreviatis; floribus polygamis apetalis; staminibus 2-4; antheris lineari-oblongis; calyce campanulato dentato; fructu 12 mm. longo, superne alato.

This species is related to *F. anomala* Torr., but the simple leaves are very different. Found near Minas de San Rafael. No. 5139. Type, Herb. Univ. Calif., No. 153477.

***Sabbatia Purpusii* sp. nov.**

Glabra, caule erecto ramoso, ca. 4 dm. alto; foliis superioribus anguste linearibus, inferioribus parum latioribus, 1.5-3.5 cm. longis; floribus longe pedunculatis, 5-meris; calycis lobis linearibus, tubo parum turbinato, angulato, 5 mm. longo, quam lobis brevioribus; corolla rosea vel flava fauce immaculata, lobis spathulato-lanceolatis calyceem superantibus; capsula ovali, 1 cm. longa.

This species differs from *S. Palmeri* Gray, as described, in having a longer calyx tube and the corolla much surpassing the calyx lobes. The flowers are rose-colored, yellow or tinged with both colors. Minas de San Rafael. No. 5345. Type, Herb. Univ. Calif., No. 155197.

***Mandevillea potosina* sp. nov.**

Volubilis, caulibus juvenibus pubescentibus; foliis oblongo-acuminatis vel rotundo-ovato-acuminatis, basi cordatis vel cuneatis, supra minute pubescentibus, subtus tomentosis pallidioribus, 5-9 cm. longis, 3-7 cm. latis; petiolis 1-2 cm. longis, tomentosis; racemis axillaribus 4-6 cm. longis, 10-15-floris, pedicellis ca. 1 cm. longis; calycibus 5-partitis, lobis deltoideis, basi intus 5-squamatis; corolla alba infundibulari tubo cylindraceo tenui, 2 cm. longo, fauce esquamata campanulata 6 mm. lata, lobis 2 cm. longis in alabastro intus dense albo-tomentosis; antheris apice acuminatis, basi in appendiculas obtusas productis, connectivo dorso processu incurvo instructo; disco 5-squamato; ovarii carpellis 2 distinctis. Folliculi desunt.

From the description this would appear to be near *M. convolvulacea* Hemsl., but from that species it differs especially in having a larger and differently shaped corolla. Near Rascon. No. 5408. Type, Herb. Univ. Calif. No. 155200.

***Fischeria? alata* sp. nov.**

Suffrutescens volubilis, caulibus pubescentibus; foliis oblongis, longe acuminatis, basi cordatis, hirsutis, ca. 5 cm. longis, 1.5 cm. latis; petiolis 2.2 cm. longis pubescentibus; pedunculis axillaribus 2-3 cm. longis; 1-4-floris; pedicellis 5-10 mm. longis; calycis segmentis 14 mm. longis, lineari-lanceolatis extus pubescentibus; corolla alte 5-fida, lobis contortis dextrorsum obtegentibus, lanceolatis extus pubescentibus, 8 mm. longis; corona exteriore annulari, carnosa, 5-lobata, corollae basi affixa; interioris squamis a dorso antherarum radiantibus, quadratis; stigmatibus vertice depressis, late 5-gono; columna brevis; pollinibus obliquis; folliculis laevibus, 5-alatis, 8.5 cm. longis.

This plant appears to be related to *F. heterophylla* Hemsl. It differs from the generic description as given in Benth. & Hook. Gen. Pl. in having no terminal lobe to the anthers. The flowers resemble those of *Gonolobus*. Pedregal near Tlalpam, State of Mexico. No. 5657. Type, Herb. Univ. Calif., No. 155211.

***Asclepias longipedunculata* sp. nov.**

Caules ultra 2.5 dm. alti, pubescentes; foliis oppositis, ovatis, acutis, basi cuneatis vel cordatis, sessilibus vel petiolatis, utrinque arachnoideo-tomentosis vetustis glabrioribus, usque ad 4.5 cm. longis, 2 cm. latis, inferioribus minoribus; umbellis ca. 15-floris, pedunculis axillaribus puberulis 1.5 dm. longis, pedicellis tomentosis 2.5 cm. longis; corollae lobis purpureis, anguste ovatis, acutis 7 mm. longis; columna brevi; cucullis basi saccatis, antheras superantibus, apice truncatis sinuato-5-dentatis, dente medio cornu cum ala parva conjuncto; cornu cucullae fere usque ad apicem adnato, exserto inflexo alte bifido.

The exserted horn is composed of two distinct laminae. Only a few imperfect specimens obtained. Collected near Bagre, San Luis Potosi. No. 5219. Type, Herb. Univ. Calif., No. 157407.

***Asclepias rafaensis* sp. nov.**

Ex radice tuberosa erecta, caulibus paucis pubescentibus ca. 1 dm. altis; foliis oppositis ovatis acutis, basi in petiolum breve cuneatis, utrinque hirsutulis, usque ad 5 cm. longis, 2 cm. latis; umbellis caules terminantibus, 10-20-floris, pedicellis pubescentibus, ca. 1 cm. longis; corollae segmentis ovato-acuminatis, ca. 3 mm. longis, brunneis, margine albescens; cucullis quam columna longioribus, stigma aequantibus, margine superne 5-dentatis, dentibus externis longioribus filiformibus, cornu fere aequilongis; cornibus cucullis usque ad medium adnatis, exsertis, supra stigma curvatis.

This small plant is near *A. scaposa* Vail, from which Dr. Rydberg, who kindly compared them for me, assures me it is distinct. The leaves, rarely ternate or in fours, are confined to the lower half of the stem. Near Minas de San Rafael. No. 5214. Type, Herb. Univ. Calif., No. 157406.

***Philibertia anomala* sp. nov.**

Glabra, caulibus volubilibus; foliis oblongo-ovatis acuminatis vel mucronatis, supra viridibus, subtus pallidioribus venosisque, usque ad 5 cm. longis, 2.5 cm. latis, petiolis 6-8 mm. longis; floribus albis campanulatis 7-9-subumbellatis; pedunculis ca. 6 mm. longis; pedicellis ca. 1 cm. longis; calycis segmentis ovato-lanceolatis brevibus; corolla alte 5-fide lobis 4 mm. longis, ovato-lanceolatis, margine tomentosis; corona interiore processibus carnosus 5, tubo stamineo adnatis, corona exterior obsoleta; columna lata brevi; stigmate vertice plano. Folliculi desunt.

The interior corona is exactly that of *Philibertia*, being formed of similar rotund processes which flatten in drying. They are very different from the ligulate appendages that form the corona of *Metastelma*. Of the exterior corona there is no evidence. Near Rascon. No. 5258. Type, Herb. Univ. Calif., No. 155271.

***Physalis campanulata* sp. nov.**

Multicaulis e radice lignosa, caulibus dense hirsuto-pubescentibus, ca. 3 dm. altis; foliis ovato-acuminatis, basi cordatis vel cuneatis, margine integris, utrinque hirsutulis, laminis usque ad 3.2 cm. longis, 1.5 cm. latis; petiolis 1.3 cm. longis, hirsuto-pubescentibus; floribus axillaribus singulis; corolla flavescente 5-angulata, rotata; filamentis 5, quam antheris oblongis longioribus; calyce fructifero aucto inflato, baccam includente, campanulato, ad medium 5-fido, 7 mm. longo; pedicello deflexo 6-8 mm. longo; bacca globosa sicca mox irregulariter rumpente semina liberante; seminibus 6-8, fere lenticularibus, rugulosis.

Allied to *P. microphysa* Rydb. which seems to have similar dry fruit and seeds. The berry of *P. campanulata* soon breaks up into narrow revolute strips that remain attached to the base, but free from the persistent dissepiment liberating the few large seeds. San Luis Potosi. No. 5313. Type, Herb. Univ. Calif., No. 155250.

***Beloperone guttata* sp. nov.**

Caules herbacei ramosi supra nodos constricti bifariam tomentosi, ramulis dense tomentosis; foliis ovatis acuminatis, margine integris, basi cuneatis, ca. 8.5 cm. longis, 4 cm. latis, utrinque pubescentibus; petiolis ca. 3 cm. longis; floribus ad axillas bractearum solitariis ramos terminantibus; bracteis cordatis vel flavo-rubris ca. 2 cm. longis, 14 mm. latis; bracteolis ovato-lanceolatis ciliatis, quam calyce longioribus; calyce ad basim 5-partito, segmentis lanceolatis fere aequalibus ciliatis; corolla extus pubescente, alba, 3 cm. longa, faucibus purpureo-guttatis, labio postico brevissime 2-lobo, antico breve 3-lobo; staminibus 2; antheris 2-locularibus, loculis connectivo dilatato, calcaratis; capsula ovoidea basi in stipitem solidum contracta; seminibus orbiculatis levibus turgidis.

This species is well marked by its white, purple spotted corolla and its large cordate red bracts. In other respects it much resembles *B. comosa* Nees. The flowers are crowded into a short, bracted spike. Collected along Rio de las Gallinas, near Rascon. No. 5263. Type, Herb. Univ. Calif., No. 155270.

Loeselia Purpusii Brandg.*Univ. Calif. Publ. Bot.*, vol. iii, 389

This plant, from seeds of the type planted four years ago, is now blooming in the garden of the University. In rich soil it has already attained a height of three feet or more with many woody stems from the base. The lobes of the corolla in these plants are nearly of the same size and the markings are similar. Their spreading is very much varied, often regular, sometimes one superior, sometimes two, and many times all superior. The filaments are inserted about the middle of the tube and are minutely glandular for their whole length.

Salvia lentiginosa sp. nov.

Perennis, caulibus herbaceis debilibus parce pilosis, ca. 3 dm. longis; foliis deltoideo-ovatis, basi truncatis vel cuneatis, supra fere glabris, subtus ad venas setulosus, rubro-punctatis, ca. 2.8 cm. longis, 3.5 cm. latis, petiolis 2 cm. longis setulosus; racemis ca. 8 cm. longis; verticillastris usque ad 6-floris, bracteis ovato-aristatis deciduis; calyce campanulato rubro-punctato, 6 mm. longo, pedicellis 1 mm. longo, labio superiore aristato, labio inferiore 2-fido, laciniis aristatis; corolla caerulea 11 mm. longa, extus pubescente, rubro-punctata, labio superiore recto, quam inferiore brevior; connectivis postice longitudinaliter connatis, callosis, semihastatis; stylo barbato.

A few specimens only, were collected near Minas de San Rafael. No. 5449. Type, Herb. Univ. Calif., No. 155262.

Hymenatherum setifolium Gray, var. **radiatum** var. nov.

Capitulis ca. 10-radiatis; ligulis oblongis, 4 mm. longis flavis; pappi squamis exterioribus parvis truncatis quadratis vel oblongis, interioribus 5, majoribus apice fimbriatis et longe aristatis.

This interesting plant is evidently a radiate and pappose form of *H. setifolium*. Dr. Gray noted a pappose form in his revision of *Hymenatherum*. Collected at Bagre, San Luis Potosi. No. 5137. Type, Herb. Univ. Calif., No. 153487.

Bidens integrifolia sp. nov.

Glabra, caulibus striatis e radice repente, ca. 6 dm. altis; foliis oblongo-ovatis petiolatis, usque ad 5 cm. longis, 2.5 cm.

latis, margine integerrimis; petiolis ca. 1 cm. longis; capitulis terminalibus subcorymbosis, longe pedunculatis radiatis, 25–30-floris; squamis exterioribus involucri anguste oblongis, acuminatis, interioribus longioribus oblongis; achaeniis truncatis 5 mm. longis, compressis biaristatis; aristis 4 mm. longis; ligulis paucis, flavis.

This species is marked by its simple entire, opposite leaves, mostly on the lower half of the stem; its few long-peduncled heads and creeping roots. Collected near Guscama, San Luis Potosi, growing along brooks. No. 5126. Type, Herb. Univ. Calif., No. 153473.

Calea (Tetrachyron) Brandegei Greenman, sp. nov.

Fruticosa erecta; caule ramoso tereti lignoso; ramis ramulisque albedo-tomentulosis; foliis oppositis brevi-petiolatis lineari-oblongis 1–2.5 cm. longis, 2.5–6 mm. latis, acutis vel obtusis basi abrupte angustatis integris subtrinerviis juvenate utrinque albedo-tomentulosis glabratibus; petiolis usque ad 6 mm. longis; inflorescentiis terminalibus cymosis paucicapitatis; capitulis ca. 6 mm. diametro heterogamis; involucri campanulati squamis 3-seriatis inaequalibus ciliolatis, exterioribus brevibus linearis 2 mm. longis, interioribus oblongis ca. 4 mm. longis; floribus femineis ligulatis 8–10, corollis flavis; floribus disci numerosis quam squamis involucri longioribus; achaeniis obeoneis minute hirtellis; pappi squamellis 4 linearibus 1 mm. vel minus longis scariosis. Mexico. State of Puebla: in rocky soil, Cerro de Coatape, altitude 2130–2440 m., August, 1908, *C. A. Purpus*, No. 5579 (Hb. Field Museum, Cat. no. 294735, type).

The technical characters of the head, particularly the involueral bracts, heterogamous flowers, and small number of pappus-scales, place the plant in the subgenus *Tetrachyron*. Specifically, however, it is very distinct from any hitherto described member of the genus *Calea*, and the writer takes pleasure in associating therewith the name of Mr. T. S. Brandege, who has made important contributions to our knowledge of the flora of Mexico.

Aspilia potosina sp. nov.

Frutescens multicaulis e radice lignosa, scabro-hirsuta, caulibus ramosis; foliis oppositis, superioribus ovato-lanceolatis, basi in petiolum brevissimum cuneatis, dentatis, 3–4 cm. longis, 8–12 mm. latis, inferioribus majoribus saepe trilobatis; capitulis

longe pedunculatis ramos terminantibus; involucri campanulati squamis 2-3-seriatis ovato-lanceolatis, exterioribus hirsutis ciliatis; ligulis 8-10, aureis, 7 mm. longis; radii floribus neutris; pappi corona fimbriata 1-2-aristataque.

Near Bagre, San Luis Potosi. No. 5162. Type, Herb. Univ. Calif., No. 157321.

Bahia Schaffneri Wats.

In these specimens some of the heads have the normal truncate pappus, others on the same plant, even in the same head, have some or all of the pappus scales terminating in a long delicate awn. Collected between San Tiburcio and Angostura, San Luis Potosi. No. 5161. Herb. Univ. Calif., No. 157357.

Sclerocarpus frutescens sp. nov.

Multicaulis, strigoso-hirsutus, caulibus basi frutescentibus; foliis inferioribus oppositis ovato-oblongis acuminatis, margine integris vel grosse dentatis, usque ad 3 cm. longis, 1 cm. latis, basi cuneatis; petiolis 2-5 mm. longis; capitulis longe pedunculatis ramos terminantibus; involucri squamis 1-2-seriatis ovato-lanceolatis; ligulis ovatis, aureis, minute bidentatis, 8 mm. longis; bracteis achaenias involventibus involucrium superantibus; achaeniis nitentibus; pappi setis brevissimis.

Collected between Bagre and Minas de San Rafael. No. 5157. Type, Herb. Univ. Calif., No. 157368.

Pinaropappus multicaulis sp. nov.

Glaber, caulibus scapiformibus e radice lignosa 1-2 dm. altis, superne ramosis; foliis radicalibus spathulatis, margine integris, usque ad 8 cm. longis, 1.5 cm. latis; involucri squamis exterioribus late ovatis subsphacelatis; achaeniis 6-8-costatis apice paulo contractis.

From the common *P. roseus* Less. this differs in its more scapose habit, in its coriaceous, entire radical leaves, its branching stems as well as other minor characters. Collected on the moist soil of the plains between Tiburcio and Angostura, San Luis Potosi. No. 5146. Type, Herb. Univ. Calif., No. 153492.

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COMPARATIVE DEVELOPMENT OF THE CYSTOCARPS OF *ANTITHAMNION* AND *PRIONITIS*

BY
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INTRODUCTION.

On finding some good material of *Antithamnion floccosum* (Muell.) Kleen at Alameda, Mr. W. C. Twiss and the writer of this article, at the suggestion of Professor Setchell, undertook to follow the processes in the development of the cystocarps in this species. Later, Professor Setchell kindly furnished us with preserved material of *A. floccosum* (Muell.) Kleen, *A. Pylaisaei* (Mont.) Kjellm., *A. boreale* f. *typica* Kjellm., *A. boreale* f. *corallina* (Rupr.) Kjellm., and also *Platythamnion heteromorphum* J. Ag. When a few of the main points had been determined, Mr. Twiss found it necessary to confine his efforts to other work which had already been commenced, and the writer continued the study of the subject at hand.

On completion of the work in connection with the *Antithamnion* and *Platythamnion* species, attention was next directed to a study of the cystocarpic development in the genus *Prionitis*, with no thought whatever of there being any close resemblances between *Antithamnion* and *Prionitis*. It was found, however, entirely unexpectedly, that the cystocarpic development in the one is very similar, in many respects, to that in the other. A consideration of both genera, including a comparative study of the two, will be the purpose, then, of this paper.

ANTITHAMNION.

The genus *Antithamnion* was founded by C. Nägeli (1847, p. 200) upon *Callithamnion cruciatum* Ag. As nothing was then known of the nature of the development of the cystocarp in any of the *Floridaceae*, he made the separation, as we should expect on differences in vegetative structure only, giving a very thorough description from this standpoint. Some time later (1861, p. 144), he lays great stress on the differences in the development of the tetraspores, and adds that there was still nothing known as to the cystocarpic development.

Schmitz (1883, p. 236), in describing the fertilization process in *Pterothamnion plumula* Näg.—later referred to *Antithamnion plumula* (Ellis) Thur.—says:

“ . . . one of the terminated lateral branches of the thallus bears, inserted at one side of its basal cell, a four-celled, short-jointed carpogonial branch, which bends its apex towards the upper surface of the branch, while, on the opposite side of this basal cell, a unicellular branch develops into the auxiliary cell, which also curves its apex towards the upper surface of the whole branch of the thallus, and thus comes into direct contact with the carpogonial cell.”

F. Hauck (1885, p. 70) makes the following statement with respect to the cystocarps of *Antithamnion*: “Cystocarps situated on the upper branches, free (not surrounded by covering branches), roundish, mostly in pairs opposite each other, or in threes, occasionally fours, together.”

Schmitz and Hauptfleisch (1897, p. 497) in effect say: The carpogonial branch is situated laterally on the basal cell of a short branch; short fertile branches are scattered on the shoot, or are accumulated in the vicinity of the end of the branch, and,

in that case, becoming less and less complex, are ultimately reduced to very small procarpic groups. The cystocarps, in most cases, owing to the stunted growth of the apical branch, become surrounded by the uppermost, and sometimes secondary nearby short branches, which thus form a covering for it.

R. W. Phillips (1896, p. 193) makes mention of having seen, during the previous summer, the conjugation process in *Antithamnion plumula* (Ellis) Thur., and later (1897, p. 356) records the results of his observations on the development of the cystocarp of this species. After describing the location of the carpogonial branch, he describes the conjugation between the carpogonium and the auxiliary cell, which, he states, takes place by means of a "stout oöblastema-tube." He states that after conjugation "the auxiliary cell forthwith grows luxuriantly into gonimoblast-filaments, made up of several gonimolobes." He alludes also to a fusion later between the auxiliary cell and the cells immediately above and below it, and further states that this fusion does not extend beyond the basal cell below.

Oltmanns (1904, p. 703) makes brief mention of the development of the cystocarp in this species, in substance as follows: The four-celled, carpogonial branch is developed on the basal cell of a short lateral branch, and is curved upward. The auxiliary cell comes from the same cell as does the carpogonial branch, and arises after the fertilization of the carpogonium. The cell supporting the carpogonial branch grows upward, and a large auxiliary cell is cut off, with which a short sporogenous filament fuses. The short branch bearing the procarp is sometimes isolated, being plainly seen; but in the case of many species a large number of branches develop near the apex. Later these branches stop their growth, and the mature cystocarp stands apparently terminal. Oltmanns leaves the subject here, stating that the details of the process are unknown, but that very likely they do not contain anything more abnormal than the development of the sporophyte.

It is evident that much remains to be worked out as to the development of the cystocarp in this genus. Gaps appear in the description, particularly with respect to the development of the cystocarp after fertilization has taken place.

As a basis of our study of the genus, we will consider *A. floccosum* (Muell.) Kleen, and later show wherein the other species, referred to above, including *Platythamnion heteromorphum* J. Ag., resemble and differ from it.

We found that the fresh material, as well as that which had been preserved, stains readily in an alcoholic solution of acid fuchsin, especially in the presence of a small amount of acetic acid and glycerine. The stained material may be mounted in glycerine.

Antithamnion floccosum (Muell.) Kleen.

The carpogonial branch arises laterally, as described by Schmitz and Hauptfleisch (1897, p. 497), Phillips (1897, p. 356), and Oltmanns (1904, p. 703), as an outgrowth on the basal cell of a short branch near the end of the shoot. In developing, it curves upward, and somewhat over the cell from which it has grown. The fully developed carpogonial branch is made up of four cells, the first three being short, while the end cell, the carpogonium, extends into a long process, the trichogyne, which is usually two or three times the length of the rest of the carpogonial branch (cf. plate 32, fig. 1). A constriction occurs in the trichogyne near its base, and, after fertilization, the trichogyne is divided off from connection with the rest of the carpogonium, and sooner or later disappears.

After fertilization of the carpogonium has been effected, a cell, rich in protoplasm, is cut off from the upper side of the same joint-cell from which the carpogonial branch arose. This is an auxiliary cell (cf. plate 32, figs. 2, 3, 4, and 5), which as a result of the above-described upward curving of the carpogonial branch comes to lie in close proximity to the carpogonium (cf. plate 32, fig. 2). The lower corner of the carpogonium, which is nearest the auxiliary cell, soon becomes extended into a short, stout tube which connects directly with the auxiliary cell, as shown in plate 32, figure 2 and figure 3, although in the latter figure an unbroken conjugating tube is not shown. This definite conjugating process has been seen many times by the writer of this article, and by others, it undoubtedly being the same process

as described by Phillips (cf. 1897, p. 356) for *A. plumula* (Ellis) Thur., and seen by Schmitz (cf. 1883, p. 236) but not described by him as a definite tube.

Immediately following the above-described conjugation, the auxiliary cell grows rapidly into a large pear-shaped cell, and, usually by transverse division, separates off a short cell from its base (cf. plate 32, fig. 3 and fig. 4); this cell soon becomes fused with the joint cell below it. Another transverse division of the auxiliary cell is made, the lower division functioning as the central cell of the cystocarp, while the upper, smaller division becomes the basal cell of the first gonimolobe. A gonimolobe in this case is a compact rounded mass of sporogenous filaments firmly enclosed in a mass of transparent jelly. These filaments are few in number (possibly two or four) and arise from the upper end of the above-mentioned basal cell of the gonimolobe which develops directly from the auxiliary cell. Figures 3, 4, and 5 of plate 32 show different stages in the development of this first gonimolobe; in figure 5, two more gonimolobes are beginning to form. As shown in the older gonimolobe in figure 5, the connections between the spores of the sporogenous filament can be readily made out. A fully developed gonimolobe is made up of a great many more spores than we see in figure 5, which represents a comparatively early stage.

Other gonimolobes arise in succession, the second from the side of the auxiliary cell at right angles with the first, the third from the side opposite the second. Later ones develop nearly at right angles with the second and third, at the same general level. As a consequence we find no two gonimolobes of the cystocarp developing simultaneously, so that while the carpospores of the terminal gonimolobe may be fully mature, those of later gonimolobes will be in a very early stage of development.

As the development of the gonimolobes goes on, there are peculiar cell fusions taking place. These fusions involve not only the auxiliary cell and the joint-cell from which it arose, but also the joint-cell connected immediately below. We have already noted above a fusion between the small cell derived from the lower side of the auxiliary cell, and the joint-cell with which it was connected. In no case, however, have we been able to

demonstrate the additional fusion of the auxiliary cell and the cell immediately above it, as reported by Phillips (cf. 1897, p. 356) for *A. plumula* (Ellis) Thur. In fusing, the pit connections between the cells concerned become widened and allow a free mingling of the contents of the two cells until it is impossible to determine just where the division wall had been situated (cf. plate 32, fig. 5).

When the carpogonial branch begins to form, the branch from which it arises is but two (sometimes three) cells in length. No more cells are added to this branch in the species we are considering, and as the carpogonial branch arises from the basal cell of the short branch, we have but one cell (sometimes two) extending beyond (cf. plate 32, fig. 5).

The mature cystocarp, then, is made up of several gonimolobes—six have been seen in many cases—unequal in size, and maturing in succession. The short branch from which it arose is not terminal, but as the cystocarp develops, the main axis becomes turned to one side, so that the mature cystocarp appears terminal. The many short branches which arise below, grow up around it, and in many cases give the appearance of a loose involucre-like structure.

OTHER *Antithamnion* SPECIES AND *Platythamnion* *heteromorphum* J. Ag.

As above indicated, a study was also made of *A. Pylaisaei* (Mont.) Kjellm., *A. boreale* f. *typica* Kjellm., *A. boreale* f. *corallina* (Rupr.) Kjellm., and *Platythamnion heteromorphum* J. Ag., to determine wherein the cystocarpic development in these species resembles or differs from that in *A. floccosum* (Muell.) Kleen. It was found in all cases—*P. heteromorphum* J. Ag. not excepted—that the development of the cystocarp follows very closely the steps already described for *A. floccosum*. The differences are very slight, appearing only in minor details. We have in every instance, a four-celled carpogonial branch; we have fertilization of the auxiliary cell by means of a conjugating tube between the carpogonium and the auxiliary cell; we have peculiar cell fusions as described; we have a cystocarp made up of several

gonimolobes, the gonimolobes developing, not simultaneously, but in succession; and we have but one cystocarp developing from a single joint-cell.

Platythamnion heteromorphum was at first described as *Calithamnion heteromorphum* by J. Agardh (1876, p. 23; cf. also De Toni, 1905, p. 1338) and later referred by him to *Platythamnion heteromorphum* (1892, p. 23). From the point of view of the cystocarpic development, except in unimportant details, there is nothing to separate it from the genus *Antithamnion*; and the differences in vegetative structure seem also not to be great enough to make the separate genus necessary. Consequently, so far as this species indicates, there seems to be no reason for continuing to regard *Platythamnion* as a genus independent from *Antithamnion*.

PRIONITIS.

It was found on looking over the literature for *Prionitis* that practically nothing had been recorded in connection with work on the cystocarp of this genus. Other genera of the family *Grateloupiaceae* had been considered from this viewpoint, although not very extensively, and in order to bring the points before us which have been brought out in connection with these genera, we will include also a consideration of the literature dealing with them.

The genus *Prionitis* was founded by J. G. Agardh (1851, p. 185) and at the same time a number of species were described. Later (1876, p. 156) he extended the description to include a more definite explanation of the location of the cystocarp, which description is used without change by De Toni (1905, p. 1586) in his *Sylloge Algarum*.

The family *Grateloupiaceae* was founded by Schmitz (1889, p. 452) and includes eleven genera. His description of the family was not published until some time later (1897, p. 509), and we have every reason to believe that that description, so far as cystocarpic structure and development is concerned, depends almost entirely on the work of Berthold (1884). Oltmanns (1904), in his description of the procarps and cystocarps of this family, refers always to the work of Berthold. So that, outside

of some work done by K. Okamura (1908, 1909, 1909a), which will be mentioned later, we find nothing of importance published except that bearing directly on, and even copied from, Berthold's single article, and of course the article itself. It seems desirable, therefore, to give a fairly thorough review of Berthold's published account, and thereby cover the field of present knowledge so far as the *Grateloupiaceae* are concerned.

Berthold's account (1884), so far as this family is concerned, is based on observations made on *Halymenia*, *Grateloupia*, and *Cryptonemia*; and these three genera, together with the genus *Schizymenia*, he placed in the group Halymenieen. *Schizymenia* was later placed by Schmitz (1889, p. 453) in the sub-family *Schizymenieae* Schmitz, of the family *Nemastomaceae* (J. Ag.) Schmitz.

In his Halymenieen, Berthold describes the female reproductive apparatus as being bottle-shaped, and as consisting of the carpogonium, with the trichogyne, which is situated on a many-celled, bent branch, out of whose cells spring branches which surround the carpogonium. The last of these enveloping filaments sits laterally on the base of the carpogonial cell itself. The auxiliary cells, according to Berthold, are morphologically homologous with the carpogonia, and, like these, are surrounded by enclosing filaments. The auxiliary cells are found in much greater numbers than are the carpogonia. Berthold's description of the further development may be summarized as follows: After the fertilization of the carpogonium, the trichogyne disintegrates and is separated from the carpogonium. Out of the carpogonium, which increases in size, conjugating filaments spring forth immediately, or after a short period. The number of the same is no less than two or three, and even may be many more. They grow in a straight line to the auxiliary cells and unite with them, whereupon the uniting portion becomes shut off by a partition wall from the remaining part of the filament, and new conjugating filaments then proceed to push forth. The cystocarps themselves are produced from the upper part of the auxiliary cells, and are made up of clusters of spores which appear, not simultaneously, but in succession. In *Halymenia*, the cells of the enveloping filaments increase in size, but not in

number, during the cystocarpic development; while in *Grateloupia*, on the other hand, the joint-cells of the enveloping filaments produce, after fertilization, side branches. The enveloping filaments on the carpogonial branches become aborted early.

Schmitz and Hauptfleisch (1897, p. 510) say that the *Grateloupiaceae* are related, on the one side, to the family *Gloiosiphoniaceae*, and on the other directly to the family *Dumontiaceae*. With both they are said to have this in common, that the auxiliary cells become situated on secondarily developing branches. They are said to differ from both in that the auxiliary cell filaments as well as the carpogonial cell filaments form bottle-shaped receptacles, in whose cavity the auxiliary cell and the carpogonium respectively lie. According to these authors they differ further from the *Dumontiaceae* in that from the auxiliary cell—as with the *Gloiosiphoniaceae*—a cell as central cell ordinarily becomes cut off.

Okamura (cf. 1908, 1909, 1909a) figures the following genera of this family: *Grateloupia*, *Halymenia*, *Carpoceltis*, *Polyopes*, and *Prionitis*. In the legends in connection with the figures, he refers to a “central cell cut off from a fused cell.” He shows procarps, cystocarps, and placental cell, but does not describe them in connection with the figures, and, so far as we know, he had not previously given a description of these parts in any detail.

The material which the writer used for this work was some *Prionitis Lyallii* Harv., collected by him at Fort Point, San Francisco, in September, 1910. It was preserved in 50 per cent alcohol and crushed or sectioned as needed. The same stain that was used for *Antithamnion* was found to be equally effective in the staining of *Prionitis*, but *Prionitis* was found to be far more difficult to study for several reasons than is the *Antithamnion*. In the first place, the reproductive apparatus, with the exception of the very end of the trichogyne, is embedded entirely within the thallus tissue. This fact necessitated the use of sections and crushed material. Sections were obtained mostly by means of paraffine embedding, although Osterhout's (1904) freezing microtome was also used, and, for some purposes, freehand sections were sufficient. A further difficulty was met with on

account of the unusually small size of the cells under consideration. This made necessary the use of an oil-immersion lens in all of the work, thereby increasing the labor considerably.

Examination of *Aeodes* and two species of *Grateloupia* was made, and thus it was possible to make comparisons between these forms and *Prionitis*. The *Grateloupia* material was dried herbarium specimens which did not lend themselves readily to preparation for examination. Nevertheless, by careful treatment, paraffine sections were obtained which gave some interesting stages.

Prionitis Lyallii Harv.

As before stated, the reproductive apparatus of this species is completely embedded within the thallus tissue. Contrary to the accepted idea, indications point very strongly to the fact that we do not have the carpogonium and the auxiliary cell produced in entirely different groups of cells. As pointed out in the discussion of the literature, Berthold was directly responsible for the introduction of this idea into the literature of the *Grateloupiaceae*, and to the present day his explanation of the conditions remains unquestioned. The fact that Berthold made his investigations soon after the publication of the work of Bornet and Thuret (1867) on the fertilization of *Dudresnaya*, perhaps suggests that his conclusions were strongly influenced by their work. Moreover, we think it possible to show how Berthold might have reached his conclusions, providing his work was not done under the most favorable conditions.

The carpogonial branch is made up of several cells (four to six), the end cell being the carpogonium, from which the trichogyne develops and pushes its way up to the surface of the thallus (cf. plate 33, figs. 6 and 7). The cell from which the carpogonial branch arises also gives rise by dichotomously branching arrangement to a normal anticlinal row of cells of the cortical region of the thallus (cf. plate 33, figs. 6-10). The carpogonial branch arises laterally from the cell which produces it, and, in its growth, it bends toward the surface of the thallus, and continues to bend until the carpogonium reaches a position between the surface of the thallus and the cell producing the

carpogonial branch. This supporting cell also cuts off, from the end nearest the thallus surface, a cell well filled with protoplasm, which functions as the auxiliary cell (cf. plates 33-34, figs. 7-12). A number of antielinal rows (at least four or five) arise either from the cell producing the carpogonial branch, or from the cells immediately connected with it, and grow upward in such a way that they come to enclose in a flask-shaped arrangement the carpogonium and the auxiliary cell. The neck of the flask-shaped structure reaches the thallus surface and later becomes the functioning carpostome for the exit of the ripe spores.

After the auxiliary cell has been cut off, and presumably after fertilization has been effected, a narrow conjugating tube, or filament, is pushed out from the carpogonium and grows directly to and unites with the auxiliary cell (cf. plate 33, figs. 9 and 10). In no case has the writer observed more than one conjugating filament produced by a single carpogonium, and that conjugating filament unites with but one auxiliary cell. The auxiliary cell, after a very decided increase in size (cf. plate 34, figs. 11 and 12), divides, and that part nearer the thallus surface becomes the central cell for the production of the cystocarp (cf. plate 34, figs. 12-15).

The central cell cuts off from its free end a cell which, by rapidly advancing divisions, gives rise to a gonimolobe in a way very similar to that described for *Antithamnion floccosum* (Muell.) Kleen. Other gonimolobes (as many as eight have been observed) arise laterally from the central cell (cf. plate 34, fig. 15) and, as in *Antithamnion*, they arise in succession, so that no two gonimolobes appear to be maturing simultaneously. At the same time as these gonimolobes are developing, very peculiar changes are taking place in the auxiliary cell, or the cell which produced the central cell (cf. plate 34, figs. 13, 14, and 15). These changes apparently are what are usually considered to be cell fusions, but, as we have been unable to demonstrate any definite fusing taking place, we prefer not to regard them as such. It may be that the auxiliary cell makes pit connections with the ordinary vegetative cells in its immediate vicinity, in each case extending a shorter or longer process to connect with the vegetative cell. We are inclined to think that this latter is the

proper explanation of the facts. By means of these connections, it seems that nutritive material is furnished to the central cell and, through it, to the rapidly developing spore clusters.

The mature cystocarp presents a very similar appearance to the mature cystocarp of *Antithamnion*, with larger and smaller gonimolobes, and enclosed in an involucre-like covering made up of vegetative cells of the inner thallus (cf. plate 34, fig. 15). Finally, as mentioned above, an opening, the carpostome, through the thallus surface permits the escape of the ripe spores.

CONCLUSIONS.

The development of the cystocarps in the *Grateloupiaceae*, at least so far as the genus *Prionitis* shows, seems to differ in very important details from the descriptions given by Berthold and which are accepted generally. Certain species of the genus *Grateloupia* that were examined only helped to confirm our opinion in this regard. Berthold refers to conjugating filaments (from two to several) growing out of the carpogonium and uniting with numerous auxiliary cells which had been produced in separate bottle-shaped groups from the carpogonial cell. Although Berthold states that the conjugating filament goes directly from the carpogonial cell to the auxiliary cell, he was never able, so far as we can determine, to follow completely such a connection. As pointed out above, we have observed but one conjugating tube, or filament, produced by a single carpogonium. This condition appeared regularly and in numerous cases, not only in *Prionitis* but also in the *Grateloupia* species, so that it seems to be a very constant feature. Moreover, this conjugating tube confines its activity to the particular group of cells in which it is produced, and in no case was it found to conjugate with more than one auxiliary cell. The carpogonial cell and auxiliary cell, then, are produced as a pair in the same bottle-shaped group of cells, the same cell apparently giving rise to the carpogonial branch and to the auxiliary cell branch.

From the point of view of the cystocarpic development, there is a very close resemblance between *Prionitis* and *Antithamnion*. In both genera the carpogonium and auxiliary cell are produced

in pairs; the auxiliary cell branch is produced from the same cell as is the carpogonial branch; a short conjugating tube makes connection between the carpogonium and the auxiliary cell; the auxiliary cell produces a cell which functions as a central cell; gonimolobes appear to be produced from this central cell in succession in *Prionitis*, but not with such apparent regularity as is very evident in *Antithamnion*.

With *Prionitis* showing such a close similarity to *Antithamnion*, it appears that the *Grateloupiaceae* are more nearly related to the *Ceramiales* (cf. Schmitz und Hauptfleisch, 1897, p. 481) than is generally conceded. In fact, from our standpoint, they show much nearer relationship than do the *Grateloupiaceae* and the *Gloiosiphoniaceae* (cf. Schmitz und Hauptfleisch, 1897, p. 505), which fact would also separate the *Grateloupiaceae* and the *Dumontiaceae* (cf. Schmitz und Hauptfleisch, 1897, p. 515) by a relatively wide gap.

In view of these conclusions and others obtained by a careful review of the literature on the *Florideae*, we are led to follow Oltmanns (cf. Oltmanns, 1904, p. 683) rather than Schmitz (cf. Schmitz und Hauptfleisch, 1897, p. 305) in the classification of the larger groups of the *Florideae*. And, for reasons which will appear obvious as we proceed, it appears necessary to regard the *Grateloupiaceae*, with the *Ceramiales*, as belonging to the *Ceramiales*.

In our investigation of the cystocarpic development in the two genera that we have discussed, we have been led to examine the criteria for the separation of the *Florideae* into groups, from the Oltmanns standpoint, as well as from the point of view of Schmitz. So far as we have been able to determine, these criteria are based on the development of the cystocarps, the presence or absence of the auxiliary cell, and the relative position of auxiliary cell and carpogonial branch. However, in no place have we found these criteria distinctly stated, although they may be quite rightly inferred from the literature.

In assigning *Prionitis* and, by inference, the rest of the group of the *Grateloupiaceae* to a position in the *Ceramiales*, in the sense of Oltmanns, we have been guided not only by the fact that the development of the cystocarp shows such a resemblance to that

of *Antithamnion*, but also by the fact that it seems to fulfill all the conditions necessary for a position in that group.

Briefly stated, it seems to us that the *Florideae* may be divided into five groups, as Oltmanns has divided them, on the following differences in their cystocarpic development:

1. NEMALIONALES:

No definite auxiliary cell is present. Gonimoblasts arise directly from the fertilized carpogonium.

2. GIGARTINALES:

Auxiliary cells are present. The auxiliary cell is the basal cell of the carpogonial branch. Connection between the carpogonium and the auxiliary cell is brought about by means of a short conjugating tube.

3. RHODYMENIALES:

The auxiliary cell is a daughter cell of the basal cell of the carpogonial branch. Connection between the carpogonium and the auxiliary cell is brought about by means of a short conjugating tube.

4. CERAMIALES:

The auxiliary cell branch and the carpogonial branch are separate, but arise from the same supporting cell. Connection between the carpogonium and the auxiliary cell is brought about by means of a short, or relatively short, conjugating tube.

5. CRYPTONEMIALES:

The auxiliary cell branches are distinctly separated from the carpogonial branches and not produced on the same supporting cell. Connection between the carpogonium and the auxiliary cells is brought about by means of relatively long conjugating filaments. A single conjugating filament may unite with several auxiliary cells.

The writer desires sincerely to thank Professor W. A. Setchell, under whom the work was carried on, for his valuable assistance, without which the results obtained would not have been possible. Thanks are also due to Mr. W. C. Twiss for many helpful suggestions.

Transmitted May 6, 1912.

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EXPLANATION OF PLATES.

All figures were sketched with the aid of the camera lucida. The procarpic and cystocarpic cells are shaded in figs. 1-12.

Abbreviations: *c.*, carpogonium; *t.*, trichogyne; *a.*, auxiliary cell; *c.t.*, conjugating tube; *f.c.*, fusion cell; *f.c'*, "fusion cell"; *c.c.*, central cell; *s.*, carpospores.

PLATE 32.

Antithamnion floccosum (Muell.) Kleen.

Fig. 1.—Portion of the end of a shoot, showing a carpogonial branch.

Fig. 2.—The conjugating process between the carpogonium and the auxiliary cell.

Fig. 3.—Beginning of the development of a gonimolobe.

Fig. 4.—Later stage, showing gonimolobe farther developed.

Fig. 5.—A still later developmental stage. Three gonimolobes are in the course of development. Notice the old carpogonial branch still persisting.

At the time of making the drawings, no definite determination of the magnification was made. From careful comparisons made later, the figures all seem to be enlarged about 375 diameters.

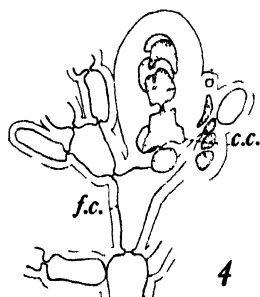
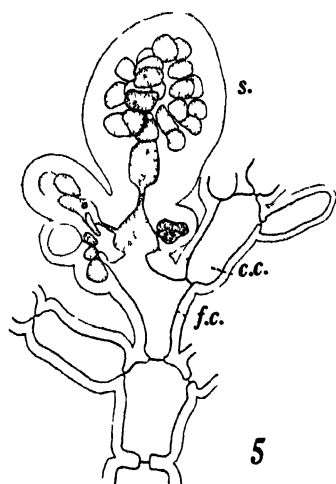
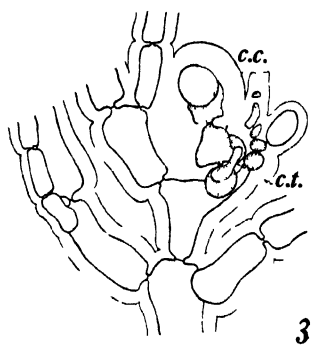
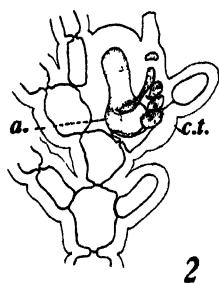
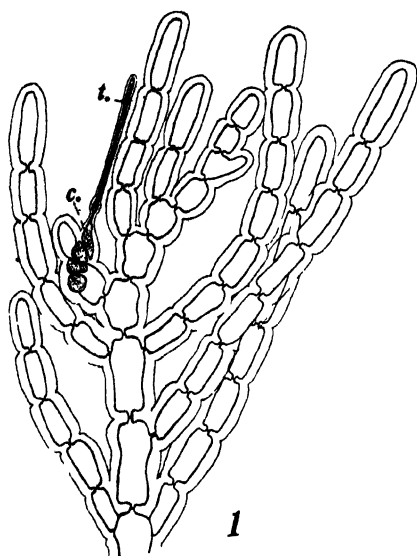


PLATE 33.

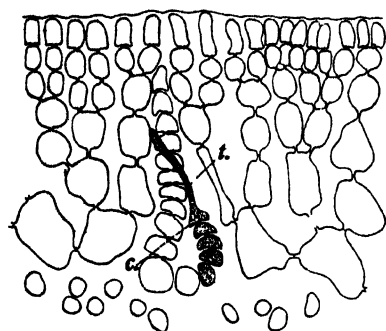
Prionitis Lyallii Harv.

Fig. 6.—Section of the cortical region of the thallus, showing a young procarp.

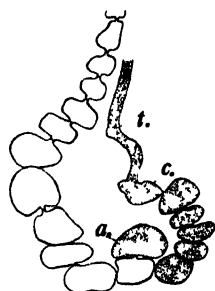
Figs. 7 and 8.—Older procarps. The auxiliary cells have been produced.

Figs. 9 and 10.—Stages showing the conjugating tube connecting the carpogonium and the auxiliary cell.

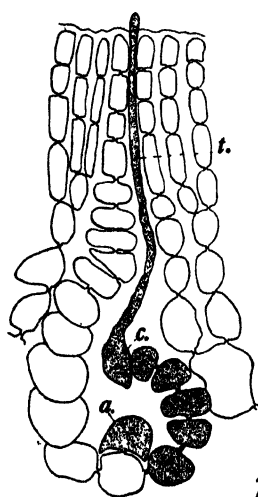
All figures drawn from cross-sections of fruiting fronds and enlarged 620 diameters.



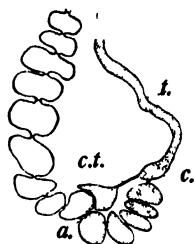
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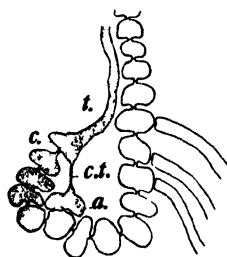
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PLATE 34.

Prionitis Lyallii Harv.

Fig. 11.—Auxiliary cell enlarging preparatory for division.

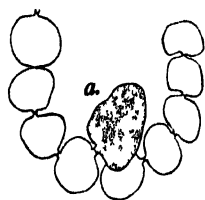
Fig. 12.—The auxiliary cell has divided, producing the central cell.

Fig. 13.—So-called “fusion cell” showing its connections with ordinary cells of the thallus. The central cell is shown with basal cells of three gonimolobes.

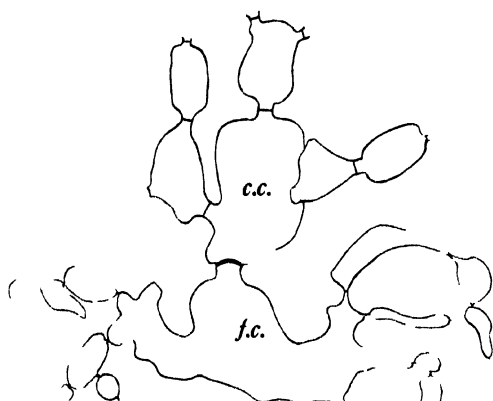
Fig. 14.—Older “fusion cell,” showing its many connections with thallus cells. The central cell lies behind.

Fig. 15.—Part of a mature cystocarp. The gonimolobes shown are later ones. The spores of the older gonimolobes have passed out of the carpostome; only the basal cells of the older gonimolobes remain.

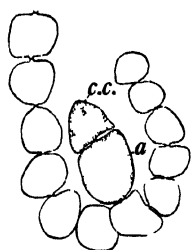
All figures drawn from cross-sections of fruiting fronds, and enlarged 620 diameters, except Fig. 15, which was enlarged 380 diameters.



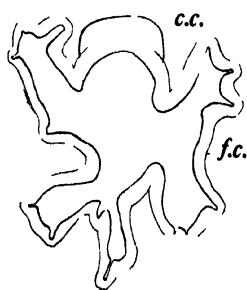
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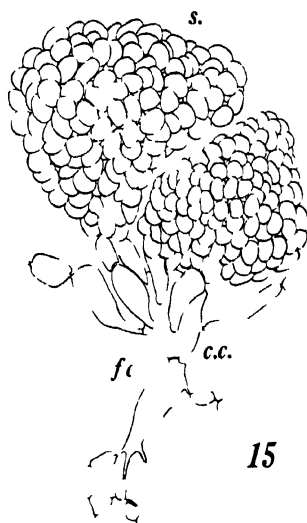
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FUNGUS GALLS ON *CYSTOSEIRA* AND
*HALIDRYS**

BY

LULA MAY ESTEE.

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INTRODUCTION.

Several species of *Cystoscira* are found along the Pacific Coast from southern California to Puget Sound. My attention was called by Professor W. A. Setchell to distortions found on one of these species, viz., on *Cystoscira Osmundacca*, and it was thought well to try to discover, if possible, the cause of these growths. Material was first collected at San Pedro by Miss Sarah P. Monks and later by Dr. N. L. Gardner. The material used in my study was collected by Dr. Gardner at San Pedro, California. It was in excellent condition and showed especially

* Originally presented as a thesis in partial fulfillment of the requirements for the degree of Master of Science in the College of Natural Sciences, University of California, May, 1912, but as published somewhat enlarged and changed.

well the later stages of development. In most cases these growths were almost spherical in general outline and made up of numerous finger-like projections radiating from a center.

Distortions of the same appearance and nature were also discovered by Dr. Gardner at San Pedro, but growing upon an undescribed species of *Halidrys*, distributed by Dr. Gardner under the name of *H. dioica* Gardner ms. (1911, Nos. cxvi and cxvii.)

HOST AND MATERIALS.

The brown alga, usually called *Cystoseira Osmundacea* (De Toni, 1895, p. 174), but referred to by Harvey (1858, p. 64) as *Halidrys Osmundacea* and by Ruprecht (1852, p. 12) as *Stephanocystis Osmundacea*, upon which these growths appear, grows attached by a disk-like root to rocks at about low-water mark. It reaches a length of five or six meters, is simply pinatifid below with broadly linear leaves. A short distance from the base the plant becomes very much divided and in place of leaves there are spherical air vesicles arranged in series with deep constrictions between the vesicles. The number of vesicles on one branch-tip varies from one to eight. The average vesicles are about 3 mm. in diameter, becoming smaller towards the end of the series, those forming first and farthest from the tip of the branch being the largest. Beyond the ends of the air vesicles are the small fruiting receptacles.

The undescribed *Halidrys dioica* of Gardner (1911) is a plant similar in general habit and habitat to *Cystoseira Osmundacea*. One of the differences between the two species of interest here, is the fact that the seriate air vesicles are not deeply constricted from one another but form, as a series, a margined and siliquaeform structure (cf. plate 35, figs. 1 and 2).

CHARACTER OF DISTORTIONS.

The growths appear near the bases of the bladders (cf. plate 35, figs. 1 and 2), the smaller being nearer the tips of the branches, while the larger, older ones are farther back. They seldom grow on the solid, main thallus, but when found in such a position, they do not seem to develop normally but have almost

globular rather than the finger-like projections such as are seen on the more healthy appearing distortions. These growths do not seem to attack the fruiting parts of the tips. They vary in size from those not more than 3 mm. in diameter and almost round to those 15 to 20 mm. in diameter and 10 mm. high. On the smaller distortions the projections are not more than 1 mm. long and 0.5 mm. in diameter, while those on the larger galls often reach 5 mm. in length and 1.5 mm. in diameter. There is no particular side of the thallus which these growths seem to favor, but where they do occur, the increased number of cells on the side infected produces a bend in the thallus. Their appearance is first noted as a tiny dark brown spot not more than 0.5 mm. in diameter. These little spots soon become wart-like, then lengthen into the finger-like projections with slightly enlarged tips.

TECHNIQUE.

The infected plants were sent to Berkeley immediately after being collected, and to preserve them for future study, they were placed in a 2 per cent. solution of formalin. After making a superficial examination of the distortions, I first made sections with a razor, and from these could obtain a good general idea of the enlargement of the thallus at the point infected and of the branching effect of the finger-like projections from this point. A small, circular, white spot could also be seen, which occupied about half of the width of the projection near its tip. Longitudinal sections of the finger-like projections were then made, using the freezing microtome, and these were very thin and smoothly cut. A number of different stains were experimented with in order to try to discover one which would differentiate the small white spot of foreign material from the algal cells surrounding it. The best results were obtained when using a very strong aqueous solution of Hanstein's aniline violet, staining the sections deeply and then partly decolorizing them by using dilute HCl. By removing the sections from the HCl and rinsing in water at just the proper moment, a beautiful differentiation of color was obtained, the cells of the alga being stained green and those of the fungus pink. The sections were then

ready to dehydrate with alcohol and mount, using either glycerine jelly or balsam, depending upon whether temporary or permanent mounts were desired.

HISTOLOGY.

Studying the longitudinal sections, two sorts of bodies, quite different in structure were found. First, the perithecia of some ascomycetous fungus (cf. plate 35, fig. 3), almost circular, from 522 to 922 μ in diameter, with an opening from the perithecium at the tip of the finger-like projection. Five or six layers of unpigmented pseudoparenchymatous cells make up the outer wall of the perithecium. Within this is a thin layer of less deeply stained tissue from which club-shaped asci arise. These, in varying stages of maturity, interspersed with empty asci line the sides and base of the perithecium, while the portion just below the opening and the opening itself are lined with short hyphal branches, directed slightly upward towards the opening. These branches almost meet, very nearly closing the opening. The asci (cf. plate 35, figs. 4 and 5) are from 90 to 145 μ long and from 9 to 30 μ wide. Each ascus contains eight spores which arrange themselves in two rows, and when mature seem to be set free in the interior cavity, filled with a jelly-like mass, by the dissolving of the walls of the ascus, and when the pressure is sufficiently great, they are forced out with this jelly through the opening of the perithecium. The spores (cf. plate 35, fig. 6) are ellipsoidal, about three times as long as broad, and when mature have a granular band across the center. The spores have a vertical diameter of from 30 to 45 μ and horizontal diameter of from 9 to 13 μ .

In some of the more nearly spherical rather than finger-like projections there are egg-shaped bodies, with long diameter of from 444 to 622 μ and short diameter from 277 to 444 μ , somewhat smaller than the perithecia, with pseudoparenchymatous walls of hyphae, finer and more delicate than those in the perithecia. These bodies seem to be of the nature of spermatogonia (cf. plate 35, fig. 7).

From the wall as seen in longitudinal section, pseudoparenchymatous cells extend towards the center of the spherical cavity

in the form of five to eight low, blunt triangles, which vary considerably in size and are irregularly placed along the wall. Short, slender, unbranched hyphae project from these triangular masses and from the wall between their bases, thus lining the entire central cavity. With the exception of the hyphae lining the opening and immediate vicinity, they abjoin successively small, oval spores (plate 35, fig. 8) from their tips, about 3μ long and 1.5μ wide, which remain in strings extending almost to the center of the interior cavity. The spores lie in a jelly-like substance with which the central cavity is filled, until the pressure becomes great enough to force the jelly containing them through the opening, which lies usually near the tip of the finger-like projection. The pore, in the case of the spermagonium, is inverted funnel-shaped rather than cylindrical as in the perithecium.

In the perithecium there are pseudoparenchymatous cells along the base of the tubelike opening which project inward toward the center of the cavity, making the tubelike opening extend downward about one-third of the diameter of the circular, central cavity. No similar mass of cells is found in the spermagonium, there being a gradual slope of the wall from the center to the external opening.

The perithecia and spermagonia do not, so far as noted, occur in the same finger-like projection or in the same distortion. Judging from the fact that these spermagonia are found in projections similar to those containing perithecia, also from their likeness in form and structure, it is extremely probable that they are spermagonia and perithecia of the same species.

There is an increased number of cells in the wall of the perithecium very nearly opposite the opening, and from this mass of cells a strand of hyphae extends downward into the finger-like process of the gall. It would appear that the infection begins with this strand which grows in length, keeping pace with the growth of the finger-like projection. The strand gives off smaller strands at its sides and finally ends as a mass of hyphal strands, from which the perithecium develops. There are other strands of hyphae extending from the perithecium besides the basal strand, but they are shorter, finer and less

branching. Much the same condition exists in the spermagonium except that the strands are more delicate, and if there are any extending from the sides of the spermagonium, they are so small that they are not readily seen.

IDENTIFICATION OF FUNGUS.

The fungus described above has a perithecium, globular or nearly so, entirely immersed in the host, through which it opens by a distinct pore. Asci line the interior of the perithecium but are not accompanied by paraphyses. The spores are hyaline, ellipsoidal, one-celled with a granular band across the center, when mature. These characters definitely indicate it as a species of *Guignardia* (ref. Engler & Prantl., *Die natürl. Pflanzenfam.*, vol. 1:1, p. 387).

It seems to be an undescribed species of *Guignardia*. No such fungus has been described as occurring on any of the *Fucaceae*. It may be compared with *Guignardia Ulvae* Reed which occurs on marine algae. The perithecium has a greater outside diameter than that of *G. Ulvae* and the asci and spores are considerably larger. The long, narrow spores also have pointed rather than rounded ends. The perithecium in our plant is from 522–922 μ transverse outside diameter, the asci are 90–145 μ by 9–30 μ , and the spores are 9–13 μ by 30–45 μ , while *G. Ulvae* Reed has a perithecium which measures 364–509 μ outside diameter and 120–270 μ internal diameter. The asci are 23–40 μ by 10–13 μ and the spores measure 3.5–7 μ by 10–13 μ . *G. alaskana* Reed is described as having a perithecium whose external diameter varies from 273–450 μ and the internal diameter from 110–216 μ . The asci are club-shaped bodies 7–14 μ by 23–40 μ , and the spores 3–4 μ by 8.5–13.5 μ .

In searching through the literature on the subject, no species of *Guignardia* has been found having spore measurement coinciding with those of the parasite on *Cystoscira* and *Halidrys* nor occurring on the same or related hosts; furthermore no known species of this genus causes any such considerable distortion of its host; therefore, in connection with Professor W. A. Setchell, I propose the name *Guignardia irritans* for this new species, naming it from the galls which it produces.

Guignardia irritans Setchell et Estee sp. nov.

G. peritheciis immersis, sphericis, 522–922 μ diam., poro apicali cylindricoque apertis, parietibus stratibus paucis pseudoparenchymaticis non pigmentatis; ascis clavatis, octosporis, 90–145 μ longis, 9–30 μ latis, parietes perithéciorum poro excepto totaliter vestientibus maturitate evanescentibusque; sporis hyalinis, oblongo-ellipticis, utrinque acute apiculatis, 30–45 μ longis, 9–13 μ latis, maturitate unicellularibus, zona granulata meridionali instructis; spermatogoniis adparentur peritheciis late remotis, oblongo-ovatis, 444–622 μ longis, 277–444 μ latis, poro apicali cylindricoque instructis, parietibus iis perithéciorum valde similibus et intus sterigmatibus simplicibus completo vestitis; spermatiiis hyalinis, late ellipticis, 3 μ longis, 1.5 μ latis, a sterigmatibus seriatim abstrictis et in gelina hyalina obvolutis. In frondibus prope vesiculas aeríferas seriatas *Cystoseirae Osmundaceae* et *Halidryos dioicae* parasitica et protuberantias gallaeformes, usque 20 mm. diam., processibus digitiformibus e centro solidiore radiantibus compositas efficiens.

Prope "San Pedro" in ditione Californiensi ubi detexerunt Domina Sarah P. Monks et Doctor N. L. Gardner.

FUNGI OCCURRING ON THE LARGER BROWN ALGAE.

As has been said above, no fungus parasites have been described as growing upon any of the *Fucaceae*. Farlow (1879, p. 10) mentions a species of "*Sphacteria*" which grows submerged in salt water, as a parasite on the stipes of *Laminaria longicurvis*, another of the brown algae. Upon examination this proves to be very different from the fungus on *Cystoseira* and *Halidrys*, as its spores are distinctly two-celled. The fungus on *Laminaria longicurvis* has been described as *Dothidella Laminariae* Rostr. (cf. Saccardo, 1895, p. 375). Upon only slightly modified portions of the thallus of *Halidrys dioica* (collected by Gardner) have also been found spermatogonia which are very much like those occurring in the distortions, except that they are less in diameter, the hyphae which form the walls are more slender and the spores smaller. This second parasitic fungus on *Halidrys dioica* grows on the stems and is entirely submerged. *Cystoseira* and *Halidrys* live at or just below extreme low-water mark, but the position of the fungus galls near the air bladders may indicate that they were partially emergent.

NATURE OF PARASITISM.

Among distortions occurring on brown algae are those upon *Ascophyllum* and *Desmarestia* described by Ethel S. Barton (1892). She says that in the case of *Ascophyllum* they are confined to that part of the thallus immediately above or below the air vesicles. The portion affected is much enlarged and covered with round swellings or lumps. Each one of these swellings upon being cross-sectioned is found to be full of nematode worms. Miss Barton states that the swellings are probably the result of stimulation from some animal secretion. The distortions upon *Desmarestia* are similar to those found upon *Ascophyllum* but have thinner walls and smaller cells. Even though these distortions somewhat resemble those on *Cystoseira* they originate from an entirely different cause.

R. Valiante (1883, p. 489) tells of a parasitic plant collected by him in the Gulf of Naples, on *Cystoseira Opuntioides*, which he calls *Streblonemopsis irritans*. He was unable to find the germinating zoospore, but began his study with the incipient mammillate form. The small plants send out branches under the epidermis of the *Cystoseira*, forming small whitish spots about 1 mm. in diameter and sometimes as excrescences resembling little galls. The peripheral cells of the *Cystoseira* enlarge with the growth of the small white spots and the contents become, little by little, granular, but almost transparent. The greatest diameter reached by the protuberances was about 2 mm. Growth of the *Streblonemopsis irritans* takes place from an apical cell extending as a prolonged thread just under the epidermis and producing, at the same time, lateral swellings which prolong horizontally and form branches. Opposing branches come together, their apices unite and form meshes of the network. As a result of this manner of ramification, branches having the same base send out side branches and unite. Sauvageau (1892, p. 351) writes of his examination of *Streblonemopsis irritans* and says that it is found only on the numerous little tubercles on the *Cystoseira* which are almost sessile on the stem. The protuberances, he says, resemble little galls, beginning as one protuberance indicated by a small whitish patch,

the enameled appearance of the epidermis returning with the recovery of the cortical tissue. At the surface of the protuberances are ramifications of the filaments which form a more or less abundant network of meshes under the epidermis. He also, by referring to the figures of Valiante, calls attention to the resemblance of the sporanges and filaments to the epidermis of the host. The galls described by these writers, although resembling the galls of our plant, are caused by a parasitic alga of the group of the *Phacophyceae* and not by a fungus.

Sauvageau has described a distortion (Sauvageau, 1892, pp. 20 and 41) produced by still another parasitic brown alga and occurring upon *Cystoseira* collected in the Gulf of Naples, to which Bornet gives the name *Ectocarpus Valiantei*. In this case the galls are not scattered regularly over one surface but are very unequally distributed, sometimes in close bunches. When the parasitic germ on the surface of the *Cystoseira* penetrates the cells of the epidermis, it does not penetrate more than two or three layers of cells deep. In a short time there is a multiplication of the cells of the host invaded, in much the same manner as occurs commonly in galls caused by the sting of insects. The filaments of the parasite do not, therefore, invade the host to any extent but surround the multiplying mass of cells. In both these algal parasites, the growth is much more superficial than it is in the fungus parasite described in this paper, which sends a hyphal strand down a considerable distance among the tissues of the host.

OTHER FUNGI ON MARINE ALGAE.

By far the greater number of fungus parasites on algae are found upon fresh-water forms, and belong, chiefly, to the groups *Chytridiaceae* and *Ancylistinaceae*. These two groups are normally more or less aquatic and show certain resemblances to the *Saprolegniaceae*. A fairly complete list of fungus parasites on algae is found in Lemmermann (1901, pp. 185–202). Of the one hundred and ninety-three species noted by Lemmermann, only ten are of the group *Pyrrenomycetaceae*, the group to which our fungus belongs, and only one of these, *Dothidella Laminariae* is found parasitic on marine algae. Reference has already been made

in this paper to this species. Only three other species of the *Pyrenomycetinae*, parasitic on marine algae, besides those enumerated in Lemmermann's list and by Reed (1902) are known to me; one, *Zignoella calospora* (Patouillard, 1897, p. 242), parasitic upon *Castagnea chordariaciformis*, collected by Sauvageau at Gigon, Spain, has the perithecia superficial, paraphyses indistinct, spores hyaline, transversely septate three to six times; the second, *Zignoella enormis* (Patouillard et Hariot, 1903, p. 228) on *Stypocaulon scoparium*, with perithecia superficial and hyaline spores four or five times transversely septate. The descriptions of these two show them to be entirely different from the fungus parasite on *Cystoseira* and *Halidrys*. The third species, however, is much more closely related to the parasite on *Cystoseira* and *Halidrys*. This is *Sphacrella Chondri* of Herbert L. Jones (1898, p. 3). In all probability this fungus, found on *Chondrus crispus*, a marine red alga, at Nahant, Mass., belongs to the genus here called *Guignardia*. Besides being on a different host and not causing any considerable distortion, it is described as having more slender asci and decidedly more slender spores. It seems, therefore, to be clearly distinct from *Guignardia irritans*.

In conclusion, I wish to express my appreciation to Professor W. A. Setchell, with whom the work has been carried on, for his kindly suggestions and criticisms; also, to Dr. N. L. Gardner of the Polytechnic High School, Los Angeles, California, for furnishing the material used.

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EXPLANATION OF PLATE 35.

Fig. 1.—Part of a series of air vesicles of *Halidrys dioica*, showing a younger gall. $\times 2$ diam.

Fig. 2.—Small section of *Halidrys dioica* with parts of three series of air vesicles, showing a mature gall on the thallus near the base of the air bladders. $\times 2$ diam.

Fig. 3.—Median longitudinal section through the tip of one of the finger-like projections of a gall, showing a perithecium and the strand of branching hyphae descending (as a darker line) from its base, between the cells of the host. The larger asci are very nearly mature and have within them large ascospores, while the asci containing smaller spores are immature. In some of the asci the spores are rounded bodies, not having yet taken the form of the mature spores. The shaded portion between the asci is gelatinous, while the lines and blank spaces in the central cavity seem to be portions of mature asci which have been forced away from the wall of the perithecium. $\times 68$ diam.

Fig. 4.—Young ascus with immature, unbanded ascospores. $\times 276$ diam.

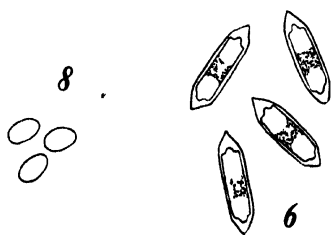
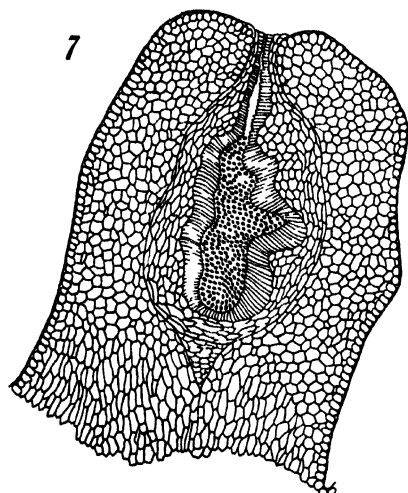
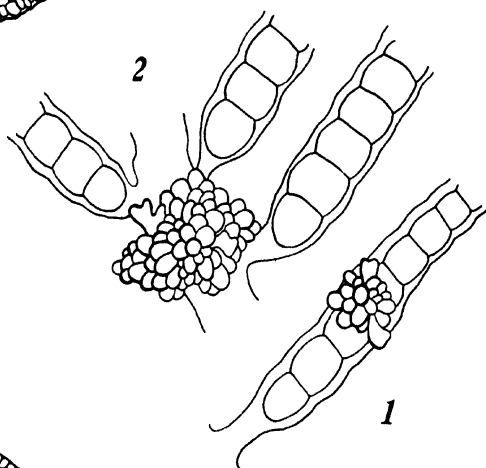
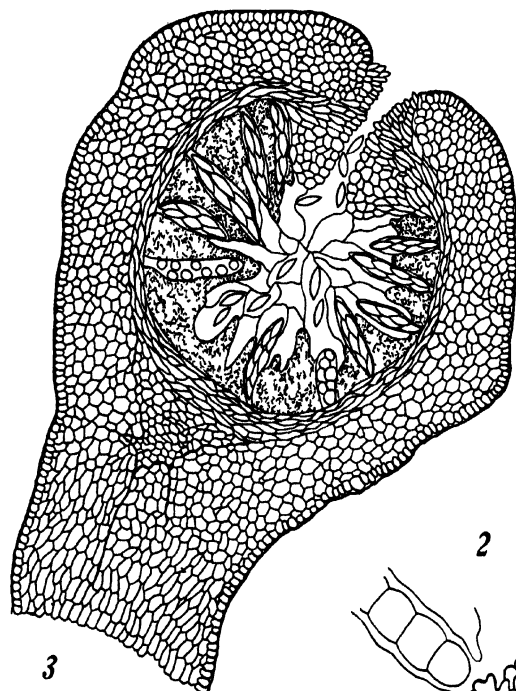
Fig. 5.—Mature ascus with mature spores, showing the central granular band. $\times 177$ diam.

Fig. 6.—Mature spores, showing rather thick, gelatinous walls, much thicker at the ends than at the sides, and the granular band across the center. $\times 329$ diam.

Fig. 7.—Longitudinal median section through a spermatogonium, showing the variation in the shape of the cells of the spermatogonium, from its wall in towards the spores, which seem to be given off, in strings, from the ends of the sterigmata. $\times 66$ diam.; somewhat diagrammatic.

Fig. 8.—Very small, oval, hyaline spermatia. $\times 1400$ diam.

All the drawings made by Lula May Estee with the aid of the Abbe camera lucida.



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NEW FUCACEAE

BY

NATHANIEL LYON GARDNER

In a previous paper of this series, "Variations in Nuclear Extrusions among the Fucaceae" (1910), in order to proceed intelligently it became necessary to give a brief systematic account of certain imperfectly understood forms of *Fucaceae* occurring on the coast of California. Since the appearance of that publication I have continued further the study of the group, with the result that several other new species have been discovered, two of which have been distributed in the *Phycotheca Boreali-Americana* of Collins, Holden and Setchell (no. CXV *b*, and nos. CXVI and CXVII, 1911).

In the present paper it has been thought advisable to give a more extended account of the new forms briefly described in the above mentioned paper, together with certain other new forms recently found on the coast of California, a few notes on some related species, and finally a new species of *Blossevilleta*, from Guadalupe Island.

Hesperophycus Setchell et Gardner

Frons a disco radicali, elongata, costata, subpinnata, evesiculosa; receptaculis discretis, terminalibus, non aut lente inflatis; cryptostomatibus in lineis duabus in utroque latere costae; oogoniis oosphaeras duas maxime inaequales amplectentibus.

Genus in habitu Fuco valde simile sed in numero oosphaerarum in oogonio differens.

Hesperophycus Harveyanus (Dec'ne) Setchell et Gardner

Growing on rocks in the upper littoral zone, in California, reported from Monterey, Santa Barbara County, San Pedro, Laguna, San Diego and San Clemente Island. (Pls. 36 and 37, figs. 1, 2, and 3.)

Gardner, Variations in Nuclear Extrusions among the Fuaceae, Univ. of Calif. Publ. Bot., vol. 4, p. 127, 1910.

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Fucus Harveyanus Decaisne.

Voyage de la Venus, Atlas de Botanique, pl. 4, 1846 (figure), Botanique (text), p. 9, 1864.

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McClatchie, Proc. So. Calif. Acad., vol. 1, p. 353, 1897.

Yates, The Marine Algae of Santa Barbara County, California, Bulletin no. 3, Santa Barb. Soc. Nat. Hist., 1902.

Fucus ceranoides (L) f. *Harveyanus* (Deene.) Kjellm.

Tilden, Am., Alg., no. 339, 1900 (Exsic.). Not of J. G. Ag., Spets.

Alg., p. 10, 1868, nor Spets. Alg. Till., p. 43, 1870. Not of

Kjellman, Alg. Arct. Sea, p. 201.

De Toni, Syll. Alg., vol. III, p. 205 (in part).

From the above array of synonymy and citations of literature and exsiccatae, it will be seen that *Hesperophycus Harveyanus* has been studied and variously interpreted by a considerable number of algologists since its original discovery. So far as we have any knowledge, the discovery was made at Monterey, California, by some one on the frigate "La Venus," which sailed along the coast of California under the command of Captain Abel de Petit-Thouars during its voyage in 1836-39.

A full-sized drawing of a whole plant, and drawings more or less in detail of several of its parts, were published under the auspices of the Minister of Marine of France in 1846, but the description of the plant by Decaisne, who referred it to the genus *Fucus*, did not appear until 1864, when the botanical text of the voyage was published. Meanwhile, Harvey in 1851 mentions the same plant in the following language: "I forbear to describe this species, named and figured by my friend M. Decaisne, some years ago, but of which no specific character has, I believe, yet appeared. It is very closely related to *F.*

ceranoides, and I am not certain by what characters it is proposed to be distinguished from that species."

Decaisne's description reads as follows: "*F. fronde plana costata dichotoma integerrima evesiculosa foraminibus crebre inspersa, receptaculis ad apices ramulorum subpalmatim congestis parvis ovatis obtusis intus fibrillis faretis, conceptaculis sporas v. antheridia foveantibus.*"

Decaisne's figure shows a distinct narrow midrib and has the cryptostomata promiscuously distributed over the whole frond. These are the characters that seem to throw doubt as to whether the plant here described is really the same as the one figured by Decaisne. Our plants are somewhat thicker in the center of the frond than at the margins, but do not show a distinct midrib even on drying. Again our plants characteristically have the cryptostomata arranged in a line near each margin, and have long exserted paraphyses, making them appear very conspicuous. This character is variable, however, in some plants the cryptostomata being somewhat profusely distributed. This is especially true of the plants found in the vicinity of Monterey.

Professor W. A. Setchell has examined the type specimen of Decaisne's species in the museum at Paris, and says that it very closely resembles Decaisne's figure. He also examined another specimen in Harvey's herbarium at Trinity College, Dublin, given to Harvey by Decaisne, collected at Monterey, which he says he thinks is exactly the same as our plant.

The writer has searched diligently in the vicinity of Monterey and along the coast to Carmel Bay, for other species of *Fucaceae* that might possibly be the plant described by Decaisne. The only other species found resembling *Hesperophycus* was a large species of *Fucus* with wide fronds and large receptacles. It is certain that this cannot be Decaisne's plant. Hence, there can be but little doubt that the plant here described is identical with Decaisne's plant.

Our California plant has certain superficial resemblances to the arctic plant, *Fucus ceranoides*. There are occasional short distichous branches which spread out, especially before fruiting, in a fan-like manner so characteristic of typical forms of *F. ceranoides*. Many of the receptacles are unbranched and are

small and pointed, like those of some forms of *F. ceranoides*, which, however, seem to be very variable in this respect, as well as in other characters. Kjellman says in his *Remarks on the forms of this species*, referring to *F. ceranoides*: "Since I have seen the excellent and highly instructive series of forms of *Fucus ceranoides*, which Kleen has brought home from Nord-landen, and had the opportunity of comparing these forms with the two forms of *Fucus* found in the Arctic sea proper, *F. Harveyanus* and *F. divergens*, I cannot but adopt Kleen's opinion that these two must not be regarded as independent species, but are, in fact, forms of *F. ceranoides*."

Kjellman is here following the opinion of J. G. Agardh, who had referred certain northern forms somewhat doubtfully to *F. Harveyanus*, not being thoroughly acquainted with Decaisne's plants of this name from Monterey. I have had the opportunity of examining several specimens in the herbarium of the University of California, under no. 132611, collected at Spitzbergen Island in 1861, and determined by J. G. Agardh as *F. Harveyanus* Dec'ne. These specimens all showed very distinctly the eight divisions in the oogonium, characteristic of the genus *Fucus*. This clearly removes all doubt as to the identity of the northern plant. It certainly is not to be confused in the future with the California plant, whose distinguishing generic character is the production of two oospheres unequal in size, only one of which is viable; and if the northern plant referred to *F. Harveyanus* is distinct from *F. ceranoides*, it must receive another specific name.

The California plant, under consideration here, is to be distinguished from the Arctic plant, *F. ceranoides*, as well as from all other species of *Fucus*, by its method of spore formation.

Pelvetiopsis Gardner

Frons a disco radicali, inferne cylindrica sed mox complanata, ecostata; receptaculis discretis, terminalibus, fere cylindricis, acuminatis; oogoniis duas oosphaeras maxime inaequales amplexantibus; cryptostomatibus sparsis in partibus juvenilibus; hermaphroditica.

***Pelvetiopsis limitata* (Setchell) Gardner**

Two fairly well defined forms of this species have been found in distinct localities along the California coast.

f. typica Gardner, fronde mediocri, 8–10 cm. longa, angusta. (Pls. 38 and 39, figs. 8–30.)

Pelvetia fastigiata f. limitata Setchell, in Collins, Holden and Setchell, Phyc. Bor.-Am., no. 1238, 1905 (Exsic.).

Pelvetia fastigiata Dec'ne. Tilden, Am. Alg., no. 233, 1898, and no. 517, 1902 (Exsic.).

f. lata Gardner, fronde longiore latioreque, 15–18 cm. longa, frequenter plus minusve contorta. (Pls. 40 and 41, figs. 31–43.)

in Collins, Holden and Setchell, Phyc. Bor.-Am., Fasc. E, no. CXIV, 1911 (Exsic.).

Gardner, Variations in Nuclear Extrusions among the Fucaceae, Univ. Calif. Publ. Bot., vol. 4, no. 6, p. 127, 1910.

f. typica has been collected at various localities along the Pacific Coast of North America from the west coast of Vancouver Island to Monterey, California.

f. lata is at present known to occur at three localities only, viz., at Point Cavallo, Marin County, California, between Moss Beach and Half Moon Bay, San Mateo County, California, and at Tomales Point, Marin County, California. At Point Cavallo it grows in a narrow zone in the very upper high tide limits, more or less shaded, and in quiet water. In the two latter localities it grows a little lower down in the littoral zone, exposed to the sun and to heavy surf.

Both forms may begin to fruit when quite young. Plants of *f. typica* have been found with receptacles longer than the remainder of the plant (*see* pl. 38, figs. 11 and 16).

The receptacles of *f. lata* are flat during the earlier part of the fruiting season, but later may become much swollen, thus resembling some forms of *Fucus* receptacles.

The principal reason for separating *Pelvetiopsis* from *Pelvetia* is the unequal division of the oosphere into two very unequal parts. This division always takes place at the base of the oogonium and is very frequently oblique instead of horizontal.

If one relied wholly upon a single character in determining the generic position of a plant, *Pelvetiopsis* might be united with *Hesperophycus*, on account of the similarity in their respective methods of oosphere formation. If this policy were pursued, however, several other genera of the *Fucaceae* would have to be united, and eventually we might again arrive at a system of classification as wholly unnatural as that proposed by Linnaeus. The morphological characters, such as color, texture, absence of midrib, etc., of *Pelvetiopsis* seem to ally it more closely to *Pelvetia* than to *Hesperophycus*, and the morphological characters, such as color, abundance of cryptostomata, a midrib, etc., of *Hesperophycus* seem to ally that genus more closely to *Fucus* than to *Pelvetiopsis*. Taking all of these points into consideration, it has seemed to the writer to accord more nearly with a natural system of classification to keep these two genera, *Hesperophycus* and *Pelvetiopsis*, separate.

Since the publication of the two new genera, *Hesperophycus* and *Pelvetiopsis*, some slight criticism has been expressed as to the undesirability of multiplying genera in the *Fucaceae*. Dr. M. A. Howe (1911) in a review of my paper, "Variations in Nuclear Extrusion among the *Fucaceae*," in which the above-mentioned genera were described, states the following: "These results suggest to the reviewer the possibility that similar accurate investigations of the number and character of the oospheres of the remaining *Fucaceae* of the world, might lead to the discovery of grounds for several other similar generic segregations, and that a large number of genera thus based might prove rather impracticable and unnatural."

In justification of the establishment of the above-mentioned genera, it might be stated that the results of the investigations necessitated following one of at least two courses: it was necessary either to extend and split up the well established genus *Fucus* in such a way as to include this newly discovered method of fruiting, disregarding as a generic fundamental the production of eight oospheres in an oogonium, or to create new genera. The author could apprehend no grave danger in pursuing the latter course. If the former policy had been pursued, there

would have been no good reason for not having absorbed into the same genus the genus *Pelvetia*, for there are no distinctive gross morphological characters by which it can be distinguished from the genus *Fucus*, and it is only when one examines into the fruiting characters with a microscope that one is able to distinguish these two genera, at least, in some of their forms. While it is true that among the *Fucaceae* many of the genera have distinguishing morphological characters associated with distinguishing fruiting characters, it is by no means safe to rely wholly upon the former for generic distinction.

Halidrys dioica Gardner ms.

Stipite perrenni e basi solida et verrucosa oriundo, tereti, ad nodos geniculato 40–50 cm. longo, 4–6 mm. in diam., solido, flexibili, non, furcato; ramis primariis (aut pinnis) annuis in stipite alterne et subdistiche positiss, sub apice crescendo oriundis, 10–18 dm. longis, basi complanatis linearibusque, superne pinnate ramulosis, ad 10–25 cm. longis et 8–12 mm. latis; ramis secundariis (aut pinnulis) sessilibus, complanatis, apicibus acutis aut obtusis, inferne integris, superne varie lobatis incisisque usque pinnatifidis; vesiculis siliquaeformibus alatis, 5–9 septatis, ad nodos lente constrictis, marginibus integris, apicibus mucronatis, basibus rotundatis; receptaculis filiformibus ramosis ad apices ramulorum ultimorum aut vesicularum; conceptaculis numerosis, mammiformibus sine ordine definito dispositis. Frondibus perennibus, dioecis, masculis et femineis conformibus.

Stipe arising from a flattened solid, warted base, terete, bent at the "nodes," 40–50 cm. long, 4–6 mm. in diameter, solid, flexible, not forked; primary pinnae annual, arranged alternately upon the stipe, always arising just below the growing point, 10–18 dm. long, flat and linear at the base, pinnately branched above, the linear portion 10–25 cm. long, 8–12 mm. wide; secondary branches or pinnules sessile, flat, acute or obtuse at the apex, the oldest ones entire, the younger ones variously notched and incised, the incisions increasing in depth, and the segments increasing in length toward the apex of the branch, the uppermost becoming pinnately branched; the upper secondary branches develop flattened, margined, lanceolate, acuminate, short pediceled air vesicles, divided into 5–9 chambers, slightly constricted at the divisions, the oldest ones rounded at the base

and mucronate at the apex; the apex of the younger ones develops farther into branched filiform receptacles which in turn bear many mammiform conceptacles; plants perennial, dioecious, the two sexes being indistinguishable by external morphological characters; color varying from dark brown to olive green; in the littoral zone on exposed rocks, or in the sublittoral zone in quiet water, at San Pedro, Redondo, and at Avalon on Santa Catalina Island, California. (Pls. 42-45, figs. 44, 45, 46, and 47.)

Gardner ms. in Collins, Holden and Setchell, Phyc. Bor.-Am., Fasc. E, nos. CXVI-CXVII, 1911 (Exsic.).

Guernsey, Notes on the Marine Algae of Laguna Beach, p. 206, First Ann. Rep. of the Laguna Marine Lab., Pomona College, Claremont, Calif., May, 1912.

Halidrys dioica is often cast ashore in abundance with *Cystoseira Osmundacea* and *C. Setchellii*, and because of its superficial resemblance to these species has doubtless been confused with them and hence has been overlooked by collectors. It is the only known *Halidrys* in the Pacific Ocean. It differs from *H. siliquosa* of the Atlantic Ocean in having smaller, wider winged, more lanceolate, shorter stiped air vesicles; in the more profusely branched fruiting ramuli which frequently arise from the side of the air vesicles; in the more "zigzag" character of the stipe and lower branches; and by being dioecious.

Like our Pacific Coast species of *Cystoseira*, *H. dioica* continues to grow until it is broken from its mooring and cast ashore, the primary branches being deciduous and the growing point inconspicuous. On rocks exposed to the surf, the fruiting branches are quite effectually worn away in the autumn, and in the winter the young flattened primary branches, being 10-15 cm. long before they begin to branch, present a quite different appearance from the mature fruiting plants of the summer. Many young plants produce fruit in abundance without producing air vesicles.

Blossevillea Brandegeei Setchell et Gardner
sp. nov.

Frondibus erectis e surculis prostratis curtisque orundis, irregulariter ramosis, ad saxa per hapteres discoideas adhaerentibus inferne cylindricis aut subcylindricis superne complanatis et costatis nonnumquam furcatis, 25–35 cm. altis, 4–6 mm. latis, alterne pinnatifidis et geniculatis; pinnis e marginibus solummodo oriundis, lente costatis, 2–3 pinnatifidis, 5–8 cm. longis; receptaculis ramulos ultimos terminantibus, 10–15 mm. longis; conceptaculis mammiformibus utroque latere lente complanatorum receptaculorum longitudinaliter et distincte biseriatis; vesiculis nullis; monoicis; oospheris in oogoniis singulis; frondibus siccis atris et maxime fragilibus.

Erect fronds developing from short, irregularly branched, prostrate filaments attached to rocks by small disk-like holdfasts; fronds cylindrical or subcylindrical at the base, gradually becoming flattened, with a midrib, occasionally forked, 23–35 cm high, 4–6 mm. wide, alternately pinnatifid, producing a geniculate appearance throughout the whole plant; pinnae arising from the margins only, slightly midribbed, twice or thrice pinnatifid, 5–8 cm. long; receptacles terminating the ultimate ramuli, 10–15 mm. long; conceptacles mammiform, usually in two fairly well defined rows on each side of the slightly flattened receptacles; air vesicles absent; dried plants black and very brittle; monoecious; one oosphere in each oogonium. (Pl. 46, figs. 48, 49, and 50.)

Type specimens in the herbarium of the University of California; no. 163378 collected by T. S. Brandegee on Guadalupe Island off the coast of Lower California in 1897; and no. 163380, a fruiting bit of a plant from the herbarium of Professor W. G. Farlow of Harvard University, collected on the same island by Dr. Edward Palmer.

When I began the study of *Blossevillea Brandegeei*, the dried specimens at hand from Guadalupe Island suggested to my mind in a vague general way a resemblance to some of the species of *Cystophora* J. Ag. in the herbarium of the University of California. Happily the material proved to be in good fruiting condition and upon microscopic examination it was ascertained that but a single oosphere develops in each oogonium, a

characteristic of the genus *Cystophora*, or *Blossevillea*, as stated by Oltmanns. However, the absence of air vesicles seemed to be a fatal objection to placing the plant in that genus. The other morphological characters, and the reproductive characters, seemed, however, certainly to ally it more closely to *Cystophora* than to any of the other related genera. A search in the literature, and a study of herbarium material, were made to learn if any other plants without vesicles had been assigned to the genus *Cystophora*.

In 1895 De Toni assembled and described twenty-four species of *Fucaceae* in his "Sylloge Algarum" under the genus *Cystophora*. One species (*C. Lenormandiana* from Hong Kong, China) was placed here with doubt and A. and E. S. Gepp have since shown that *C. elongata* of De Toni's list is identical with *Carpophyllum angustifolium*, becoming according to the Vienna rules, *Carpophyllum elongatum*.

Since 1895 but two other species have been added to *Cystophora*, *C. cuspidata* J. Ag. (1896) and *C. elongata* J. Ag. (1897). This makes a total of twenty-four fairly well defined species belonging to this genus, some of which date back to Dawson Turner (1811). J. Agardh proposed the name *Cystophora*, "vesicle bearer," in 1841, and in 1848, in "Species Algarum," he assembled nineteen species under the genus. Fifteen of these were retained by De Toni. Among Agardh's species five had been published by Turner under "*Fucus*," and one of these, *C. paniculata*, first collected by Mr. Brown at Kent's Island, off the coast of Australia, has no air vesicles. It thus appears that Agardh himself included forms without vesicles. In some other species of the genus the vesicles are either absent, unknown, or rare, while in others they are very abundant. This condition of variability also holds good among the species of *Cystoseira* Ag.

Taking the above facts into consideration, it seems best for the present, at least, to place our plant of the northern region with those of the southern hemisphere—that is, with that group of *Fucaceae* which has been variously designated by different authors at different times under *Cystoseira*, *Blossevillea*, *Cystophora*, etc.

It is not my purpose in this paper to attempt to define the limits of these various genera, but the matter of the selection of a generic name for our plant seems to lie between *Blossevillea* and *Cystophora*, as these two names seem to be held to be synonymous by the majority of the algologists. *Blossevillea* was established by Decaisne in 1840 and *Cystophora* by J. G. Agardh in 1841. Neither of these authors, however, in making his diagnosis mentioned any particular species either for their type, or as included in the genera proposed. In each case it seemed to be intended to separate these southern forms from the European forms, all of which had previously been included by C. A. Agardh under *Cystoseira*. I quote below the characterization of these genera by each of these authors, neither of which alone is sufficient to distinguish it from nearly related genera.

“Je divise le genre *Cystoseira*, en prenant pour base de ces divisions la disposition des réceptacles portés sur des ramifications des frondes ou plongés dans les frondes elles mêmes; je donne le nom de *Blosvillea* a toutes les especes de l'Océan austral; elles sont caractérisées par la courbure et le mode d'insertion des rameaux sur la face plane de la tige principale, et par la structure des réceptacles, dans lesquels les conceptacles forment deux séries parallèles, tandis que dans les vrais *Cystoseira*, ces conceptacles sont placés sans ordre apparent.”—J. Decaisne, 1840.

“Hoc autem genus in duo tunc quoque dilabitur. 1. *Cystophora* vesiculis subsphaericis in pedicello solitariis et ramis retroflexis insigne, species Australasiae continens; 2. *Cystoseira* vesiculis plus minus ellipticis in ramo inflato moniliformiter concatenatis, concatenatio, et apotheciorum ortu ex inflatis spinarum confluentium basibus distinguendum, species praecique Europeas continens.”—J. G. Agardh, 1841.

In 1842 Decaisne first published a list of five species of *Blossevillea*, all of which are retained by De Toni under *Cystophora*, but Agardh did not publish his list of species of *Cystophora* until 1848. Since Decaisne's diagnosis of the genus appeared before that of Agardh, and since the publication of Decaisne's list of species of *Blossevillea* antedates the publica-

tion of Agardh's list of *Cystophora*, we have been compelled to adopt *Blossevillea* for the name of our plant, rejecting the original spelling *Blosvillea* as evidently a "typographic error."

All of the other species of *Blossevillea*, except *B. Brownii*, are inhabitants of the region of Australia and New Zealand. *B. Brownii* was first collected by D'Urville on the coast of Chili during the voyage of "La Coquille," 1822-25, and determined by Bory de St. Vincent. *B. Brandegeei* is now the only known member of this genus of the southern waters in the north temperate zone. How to account for its presence so far away from the other members of the genus, thus becomes a matter of no little interest and importance in geographical distribution.

It may be desirable to explain why the Guadalupe plant is not referred to the genus *Bifurcaria* Stack., since it has a creeping rhizome-like base and "bilateral," rather than "radial," branching (cf. Gruber, 1896, p. 29, etc.), but the possession of the first mentioned structure can hardly be considered to be a basis for generic character, and while the genus *Cystophora* J. Ag. is ranged with the radial *Cystoseirae* (Gruber, 1896, p. 30), it is admitted that certain species of the genus are "bilateral" (cf. Gruber, *loc. cit.*). The strongly monopodial and pinnate character of the branching, the zigzag axis, and the apparently deciduous pinnae of the Guadalupe plant seem to indicate a much closer relationship to *Cystophora* J. Ag., i.e., *Blossevillea* Dec'ne. than to *Bifurcaria* Stackh.

Guadalupe Island is situated in latitude 29 degrees north, and is a little over a hundred miles off the coast of Lower California. It lies within the eastern part of the great Japanese current flowing from the north, and the prevailing winds are northerly. We should expect that these agencies might have had in the past a profound influence in determining the kinds of plants that now inhabit the island. Of the character and quantity of the marine flora we know practically nothing, but a systematic study of the land flora has indeed shown that the majority of the plants found there are not like those of the adjacent coast of Lower California and Mexico in the same latitude, but like those of California south of San Francisco, and ranging eastward. About forty per cent of the land flora

is said to be the same as that of California, which indicates a probable southern migration, doubtless due to the above-mentioned agencies. Several species, notably the wild oats and filaree, plants introduced into California, have recently gained foothold on the island.

The most interesting feature in this connection, however, is the fact that of about one hundred and thirty species of land plants, about thirty are at present known to be endemic. This indicates that at least the land flora is of ancient origin.

***Cystoseira Setchellii* sp. nov.**

Stipite perenne e basi irregulariter conica solidaque oriundo, flexibili, cartilagineo irregulariter et sparse furcato, 2-3 dm. longo, 8-10 mm. in diam., triangulari in sectione transversali, ramos numerosos, alternos, complanatos, approximatos sub apice crescendo emittente; ramis complanatis annuis, deciduis, cicatrices conspicuas defoliatione facientibus basi serratis, medio pinnate lobatis aut pinnatifidis, apice pinnate in ramulis filiformibus dissectis, ramulis serratis, lobatis, et dissectis; vesiculis, 1-3 seriatis, sphericis, 6-8 mm. in diam., ad bases ramorum ramulorumque lateraliter positis, apicalibus mucronatis; receptaculis ramulos terminantibus, 15-25 mm. longis. Planta tota 6-8 dm. longa, fusca, siccitate atra; dioica, mascula et feminea conforma.

Stipe developing from an irregularly conical-shaped solid base, flexible, cartilaginous, irregularly and sparingly forked, 2-3 dm. long, 8-10 mm. in diameter, triangular in cross section, giving rise to numerous alternate flattened branches at short intervals, always from just below the growing point; flattened branches coriaceous, annual, deciduous, thus producing prominent scars on the stipe, serrated at the base, deeply and pinnately lobed or divided in the middle, 3-4 times pinnately divided into filiform ramuli at the apex; the pinnate segments may in turn become serrated, lobed and divided; receptacles terminal on the ramuli, 15-25 mm. long; air vesicles 1-3 seriate, terminal one frequently mucronate, spherical, containing internal, longitudinal white fibers, without a margin, 6-8 mm. in diameter, situated at the base of the serrated segments, or at the base of the filiform branches; whole plant 6-8 dm. long; the color of the living plant

dark brown, turning black when dry; perennial; dioecious, the two sexes being very similar in external appearance; in the sublittoral zone at San Pedro and Redondo, California. (Pl. 38, figs. 4, 5, 6, and 7, and pls. 47-50, figs. 51, 52, 53, and 54.) It has been distributed in Collins, Holden and Setchell, Phyc. Bor.-Am., Fasc. E, no. CXV b, 1911, as an antheridial plant of *C. Osmundacea*.

In 1908 when I began to collect and study the forms of *Cystoseira* growing at San Pedro, California, I discovered a number of short, but otherwise well developed plants belonging to the above genus, and upon microscopic examination of a considerable number of specimens, it proved by chance that all of them were antheridial. I then examined a number of the long fruiting specimens of the genus which were abundant in that locality, and singularly enough they proved to be oogonial plants. Consequently, I concluded that there existed a sort of dimorphism in this species which had hitherto been overlooked, and proceeded without further critical examination to collect the two forms for distribution under *Cystoseira Osmundacea* in the above-mentioned work. Later I found oogonial plants among the short forms, which led to the discovery of antheridial specimens among the long forms. Corresponding morphological differences, such as a difference in the number of air vesicles, proved by more study to be constant in each form; hence, I have concluded after careful study that the long plants and the short ones belong to two distinct species, one of which is new to science, and this I propose to dedicate to Professor William Albert Setchell, who has always given to me so unsparingly his time, and has been so helpful to me in my research on the Pacific Coast algae.

I have not yet discovered any superficial characters by which the two sexes of these two species may be determined. The main stipe arises from a solid disk-like base or "holdfast" which later becomes conical in general appearance, but more or less irregular in outline, and of a fibrous consistency. The main stipe gives rise to other stipes, which seem to arise by a division taking place at the growing point. This matter has never been

definitely settled, but the evidence for the conclusion expressed here is that there is no noticeable difference in size at the junction of any two divisions, and all of these branches are the same in size throughout their entire length below the secondary branches. They are 8–10 mm. in diameter, and vary in length with age; triangular in cross section with sharp angles; and give rise to numerous flattened branches at frequent intervals, thus producing very short “internodes.”

These flattened leaflike branches are alternate upon the stipe and are deciduous, leaving prominent conspicuous scars on the stipe, which becomes slightly bent at those points. The flattened branches grow to be 30–40 cm. in length, and 3–5 cm. wide. Considerable variation exists among the succeeding divisions of these branches. On very young plants, and the young branches on older plants, they are deeply serrated with alternate distichous divisions. On young plants, and occasionally on older ones, a few of these divisions near the apex are metamorphosed directly into filiform ramuli, with but few air vesicles at their base, and become the receptacles and bear the fruit. (See pl. 38, fig. 4.) On other and older plants, the incisions may extend deeper and the segments become much longer and rounded at the outer end, some toward the apex even becoming 15–18 cm. long, and they in turn becoming alternately and distichously serrated, while at their ends the filiform ramuli bearing receptacles and fruit appear. (See pl. 48, fig. 52.)

More frequently, however, these latter serrated divisions do not appear, but the segments metamorphose directly into quite long—8–12 cm.—variously branched fruiting ramuli.

Thus, in a case of extreme branching of the plant we may have the main triangular stipe (*a*) which may branch to form other triangular stipes, (*b*) these in turn give rise to flattened branches, (*c*) whose segments (*d*) may in part bear similar segments (*e*) which may be variously divided into filiform fruiting segments, (*f*), (*g*), etc. The oldest plants are rarely over 75 cm. long.

On a medium-sized plant there are usually from three to five branches (*c*), on each branch (*b*), bearing fruit in a single season, while several smaller branches are maturing near the growing

point preparatory for the next year's fruiting. The first season's growth of branches (*c*) seems to arise directly from the "hold-fasts," but careful observation will reveal a short terminal, though seemingly lateral, growing point. The growing point is rather inconspicuous even in a mature plant.

The air vesicles are short, consisting of one, two, or three moniliform divisions, which are 6–8 mm. in diameter, and which are formed by deep constrictions. The terminal one is usually mucronate. They are developed at the base of the flattened branches, (*d*), taking the place of one, two, or three segments, or they may be located farther up at the base of the fruiting ramuli. (See pl. 38, figs. 4–7.) The receptacles are terminal, 15–25 mm. long, bearing numerous conspicuous conceptacles, disposed in no definite order. The fruiting ramuli of a well-developed plant are quite dense, and on this account in a superficial way resemble a cluster of grapes in outline. (See pl. 49, fig. 53.)

Cystoseira Setchellii may be easily confused with *C. Osmundacea* f. *expansa*, especially with the young and with the dwarfed specimens of the latter growing in tide pools, as is frequently the case. *C. Setchellii* seems to be exclusively a deep water plant. I have seen hundreds of specimens which have been cast ashore, but have never seen any growing in position, while *C. Osmundacea* f. *expansa* is a plant of the rock pools and the upper sublittoral zone. The color of the two plants is practically the same, yellowish brown.

C. Setchellii is to be distinguished from *C. Osmundacea* f. *expansa* by the more serrated character of the (*c*) branches of the young fronds, the larger size and fewer in number of air vesicles, being from 1–3 chambered in a moniliform series in *C. Setchellii*, and from 8, even up to 20, chambered moniliform series in *C. Osmundacea* f. *expansa*. They are particularly to be distinguished by the length of the fruiting portions, which in *C. Setchellii* are only from fifteen to twenty centimeters long, while in *C. Osmundacea* they average from three to three and a half meters long, and I have measured some plants of f. *expansa* growing at San Pedro, California, in comparatively quiet water, that were five meters long.

Nothing is definitely known as to the age of these plants, but judging from the scars formed by the deciduous branches on the longest stipes, some of them must attain the age of fifteen years before being torn loose and cast ashore.

***Cystoseira Osmundacea* (Menz.) Ag.**

(Pls. 51 and 52, figs. 55 and 56.)

Sp. Alg., vol. I, p. 69, 1821; Syst. Alg., p. 287, 1824.

De Toni, Syll. Alg., vol. III, p. 174, 1895.

McClatchie, Proc. So. Calif. Acad., vol. 1, p. 353, 1897.

Collins, Holden and Setchell, Phyc. Bor.-Am., no. XCVI, 1905, and CXV a, 1911 (Exsic.).

Halidrys Osmundacea Harvey.

in Hooker and Arnott, Bot. Beechey's Voyage, p. 407, 1841; Ner. Bor.-Am., part I, p. 64, pl. II, 1851.

Kützing, Phyc. Gen., p. 359, 1843; Sp., p. 604, 1849; Tab. Phyc., X, p. 23, Tab. 62, f. II, 1860.

Agardh, J. G., Sp. Alg., p. 237, 1848.

Farlow, Proc. Am. Acad., vol. 10, p. 353, 1875; Report of U. S. Fish Com. for 1875, p. 206, 1876.

Farlow, Anderson and Easton, Alg. Am.-Bor., no. 106, 1879 (Exsic.).

Anderson, Zoe, vol. II, p. 221, 1891.

Howe, Erytheu, vol. 1, pp. 65, 67, 1893.

Stephanocystis Osmundacea Trevisan.

in Endlicher, Gen. Plau., suppl. III, p. 31, 1843.

Ruprecht, Neue Pflanzen, p. 12 (68), pl. III, 1852.

Fucus Osmundaceus Menzies.

in Turner, Fuci, vol. II, p. 92, pl. 105, 1809.

Cystoseira Osmundacea f. *expansa* (Ag.) Setchell.

Collins, Holden and Setchell, Phyc. Bor.-Am., no. XLVIII, 1901 (Exsic.).

Cystoseira expansa Ag.

Syst. Alg., p. 290, 1824.

J. G. Ag., Sp. Alg., vol. I, p. 226, 1848.

Harvey, Ner. Bor.-Am., part I, p. 66, pl. I b, 1851.

Cystoseira Douglassi Harvey.

in Bot. Beechey's Voyage, p. 407, 1841.

Sirophysalis expansa Kütz.

Sp. Alg., p. 603, 1849.

So far as we have any authentic recorded knowledge of this interesting member of the *Fucaceae*, Archibald Menzies first brought it to the attention of the European algologists. He is reported to have discovered and collected it at Port Trinidad.

Humboldt County, California, in 1793. From some of the early descriptions which we have of it, it would seem that he collected only fragments and these mostly young.

We are indebted to Dawson Turner for the first published account of it, which appeared in his *Fuci* in 1809. Turner laments the fact that he had what seemed to him to be only a fragment of the plant in an immature stage of growth. But at the same time he felt confident that from the very marked characters of the portions that he had at hand, this plant was unlike any described species. His drawing faithfully represents what we now know to be a fairly well developed branch of a plant, showing the flattened pinnate portion, merging into moniliform vesicles and finally into the variously branched upper portions which later become much extended and develop the receptacles. On account of the pinnate nature of the flattened portion, which resembles the leaves of species of the genus *Osmunda*, Menzies suggested to Turner that *Osmundaceus* be adopted as the specific name. Following the accepted idea of the time, that all the large brown seaweeds, etc., should be placed under the genus "*Fucus*," Turner first published the name for our plant as *Fucus Osmundaceus*. Since Turner has given to us our first published account, it would seem more fitting to ascribe the authorship to him than to Menzies and this has sometimes been done.

In 1821 C. A. Agardh established the genus *Cystoseira* and grouped under it a large number of vesicle-bearing *Fucaceae*, including *Fucus Osmundaceus* Turn. In 1824 he also published *Cystoseira expansa*, based upon material found "in mari australi." It is not definitely known upon what material this species was founded, for no subsequent authors have referred to it from the southern locality. Possibly he may have had access to material collected by Menzies in 1793, and incorrectly labeled. At the time of Agardh's publication Douglas and Coulter had not yet visited our coast.

Harvey published an account in 1841 of material collected by Douglas in 1830 at Monterey, as *Cystoseira Douglasii*. J. G. Agardh, in 1848 (p. 226) placed *C. Douglasii* Harv. as a synonymy under *C. expansa*, but states further "Hab. in mari

Pacifico ad oras Californiae (Douglas!).” This indicates that J. A. Agardh must have felt certain that the material upon which *C. expansa* was founded is identical with material collected by Douglas at Monterey.

A careful study of herbarium material collected at various well-known localities along the California coast from Mendocino County to San Diego; and more particularly, a study of living material growing in position and cast ashore, has led to the conclusion that all of the above references really concern but one and the same species, which is subject to considerable variation due to differences in habitat and locality.

The type locality of *C. Osmundacea* is Port Trinidad, California, and the only reference we have of its occurrence farther north is one by L. M. Turner, who has placed a plant under *Halidrys Osmundaceus*, doubtless referring to the above plant, from Sannak Island, Alaska. It is quite possible that the plant referred to may be *Cystophyllum geminatum* (Ag.) J. Ag., which is common in the Northern Pacific region. The present definitely known southern limit of *C. Osmundacea*, on the other hand, is San Diego, California.

I have grouped the literature and the plants in exsiccatae, as best I can with the present data, into two groups. One group under *C. Osmundacea* includes references to the typical forms growing in situations exposed to heavy surf, and in the northern part of the range. Such plants agree thoroughly with the description and plate of Turner (*loc. cit.*) and are usually shorter but much more robust in all of their morphological characters than those referred to under the second group, viz., *C. Osmundacea* f. *expansa*. These two groups simply represent the extremes of a species, between which there are all possible gradations in every morphological feature. It is proposed here to distinguish these two groups in a general way as follows: •

***C. Osmundacea* (Menz.) Ag. f. *typica* comb. nov.**

Fucus Osmundaceus Menzies in Turner, *Fuci*, vol. II, p. 92, pl. 105, 1809.

Plants growing in localities exposed to the surf; fruiting portions comparatively short, less branched and more robust, air vesicles large, not very numerous, flattened fronds, robust and simply pinnate. (Pls. 51 and 52, figs. 55 and 56.)

***C. Osmundacea f. expansa* (Ag.) Setchell**

Plants growing in sheltered places, fruiting portions very long, paniculately much branched, attenuated; air vesicles small, numerous; flattened fronds often twice or thrice pinnatifid.

The average length of the mature fruiting plants belonging to the first group is from 2 to 3 m., and of those of the second group from 3 to 6 m. (Pl. 53, fig. 57.)

Occasionally fragments of the upper portion of plants have been found cast ashore in southern California, which possibly may represent still another distinct species. They somewhat resemble the fruiting portions of *f. expansa* of the above; but the character of the vesicles more nearly represents those of a *Cystophyllum*. It will not be possible to place such forms with certainty until the whole plant can be found and more critical study put upon it.

In conclusion I wish to express my sincere appreciation for the generous assistance rendered by Professor W. A. Setchell in the preparation of this paper.

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EXPLANATION OF PLATES

Plates 36, 42, 43, 44, 45, 47, 48, 49, 50, and 53 were photographed by Chas. A. Bowser; and plates 37, 38, 39, 40, 41, 46, 51, and 52 were photographed by M. B. Nichols.

PLATE 36

Hesperophycus Harveyanus (Dec'ne.) Setchell et Gardner

Fig. 1.—A young plant showing the exserted paraphyses from cryptostomata along the margins of the fronds.

Fig. 2.—A mature plant representing the fruiting receptacles. Photographed from fresh material collected at San Pedro, California, in September. One-eighth natural size.

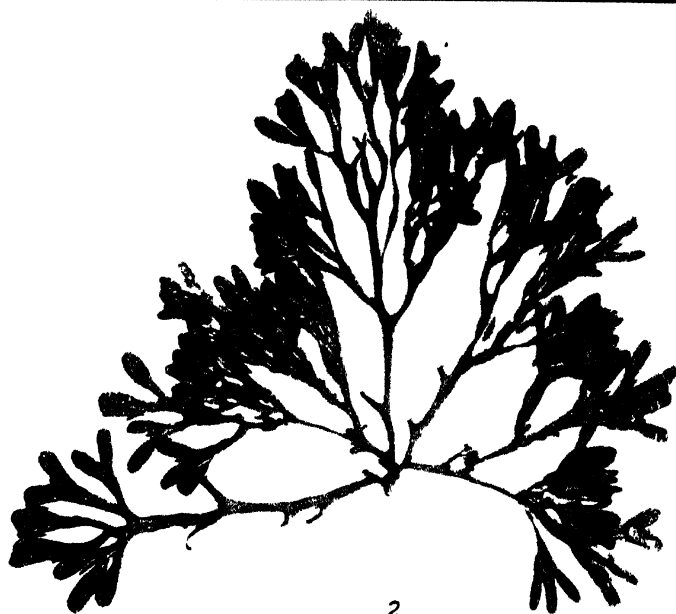


PLATE 37

Hesperophycus Harveyanus (Dec'ne.) Setchell et Gardner.

Fig. 3.—Photographed from dry specimen collected at Monterey. One-eighth natural size.

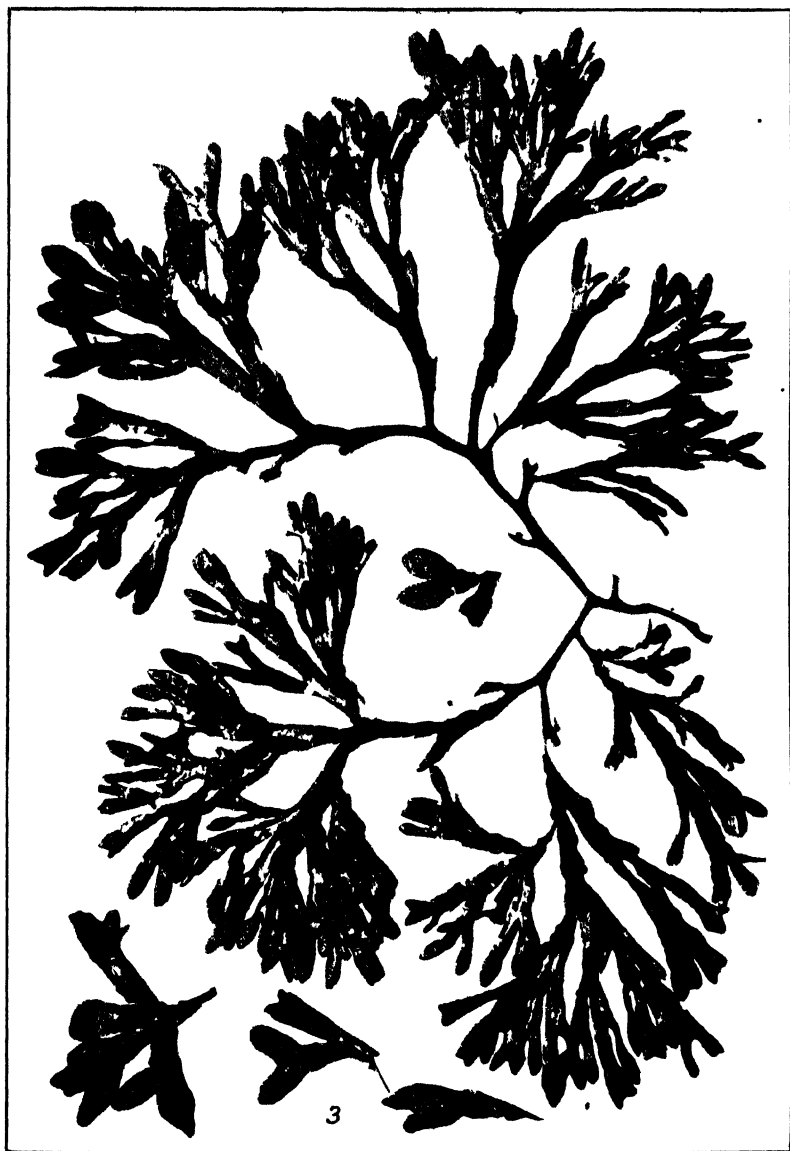


PLATE 38

Cystoseira Setchellii sp. nov.

Figs. 4-7.—Portions of the flattened frond showing the position of vesicles and the number in a series. One-third natural size.

Pelvetiopsis limitata f. *typica* Gardner.

Figs. 8-16.—Various ages and forms. One-quarter natural size.

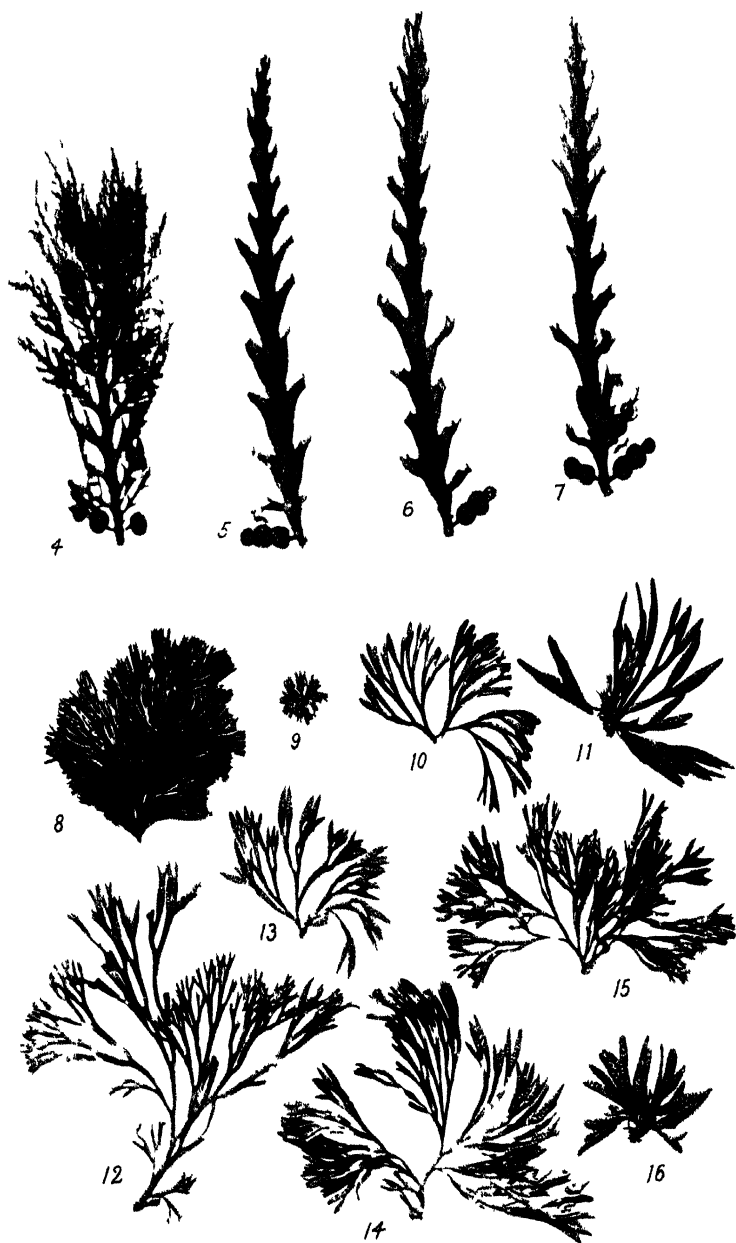


PLATE 39

Pelvetiopsis limitata f. *typica* Gardner.

Figs. 17-30.—Showing various forms of receptacles slightly reduced.

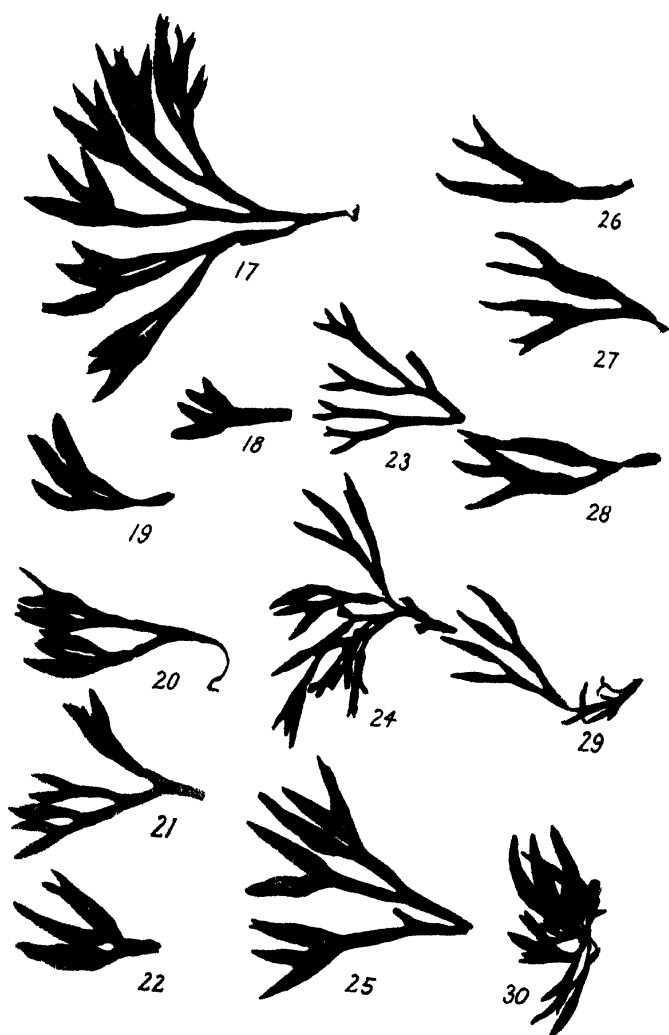


PLATE 40

Pelvetiopsis limitata f. *lata* Gardner.

Figs. 31-33.—Fruiting plants. Photographed from living material.
One-quarter natural size.



PLATE 41

Pelvetiopsis limitata f. *lata* Gardner.

Figs. 34-43.—Showing various forms of receptacles, natural size
Photographed from living material.

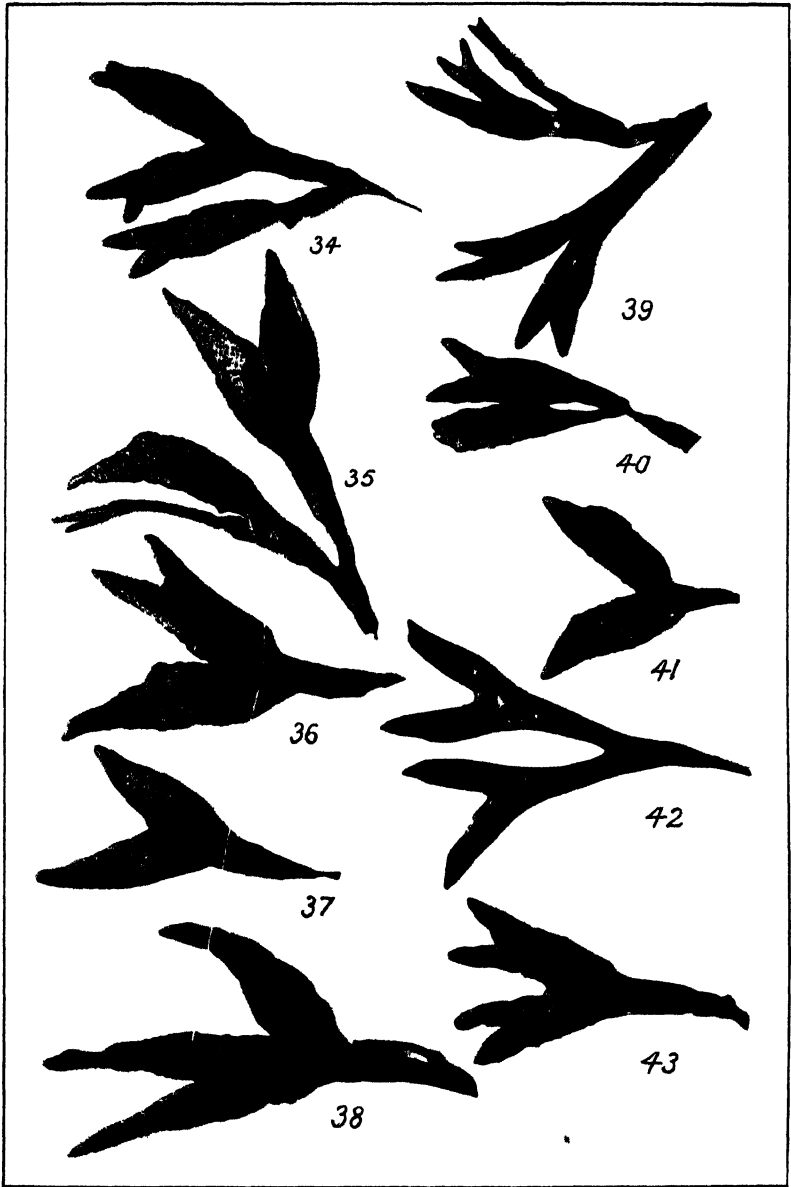


PLATE 42

Halidrys dioica Gardner.

Fig. 44.—Showing all of the different parts of a well developed robust plant. One-twentieth natural size.



PLATE 43

Halidrys dioica Gardner.

Fig. 45.—Showing the character of the stipe, holdfast, and primary branches with fruiting parts cut off. Much reduced.



PLATE 44

Halidrys dioica Gardner.

Fig. 46.—Showing the extreme in the branching of the mature receptacles, some arising from the air vesicles, and these branches in turn producing other air vesicles.



PLATE 45

Halidrys dioca Gardner.

Fig. 47.—A part of a rare form, not quite mature, showing an abundance of small air vesicles. Much reduced.

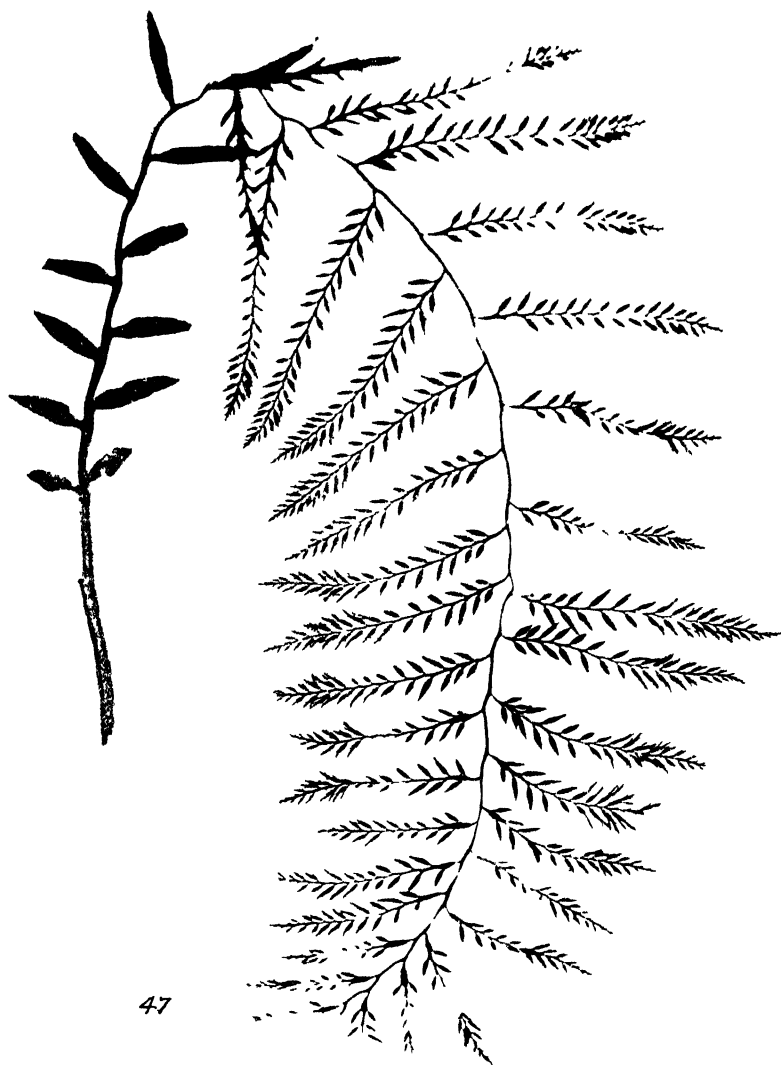


PLATE 46

Blossevillea Brandegeei Setchell and Gardner, sp. nov.

Figs. 48-50.—Photographed from dry material. Fig. 48 represents a considerably mutilated plant, showing the base and main fronds. Fig. 50 shows the characteristics of branching. Fig. 49 shows a fruiting tip of a frond. One-quarter natural size.

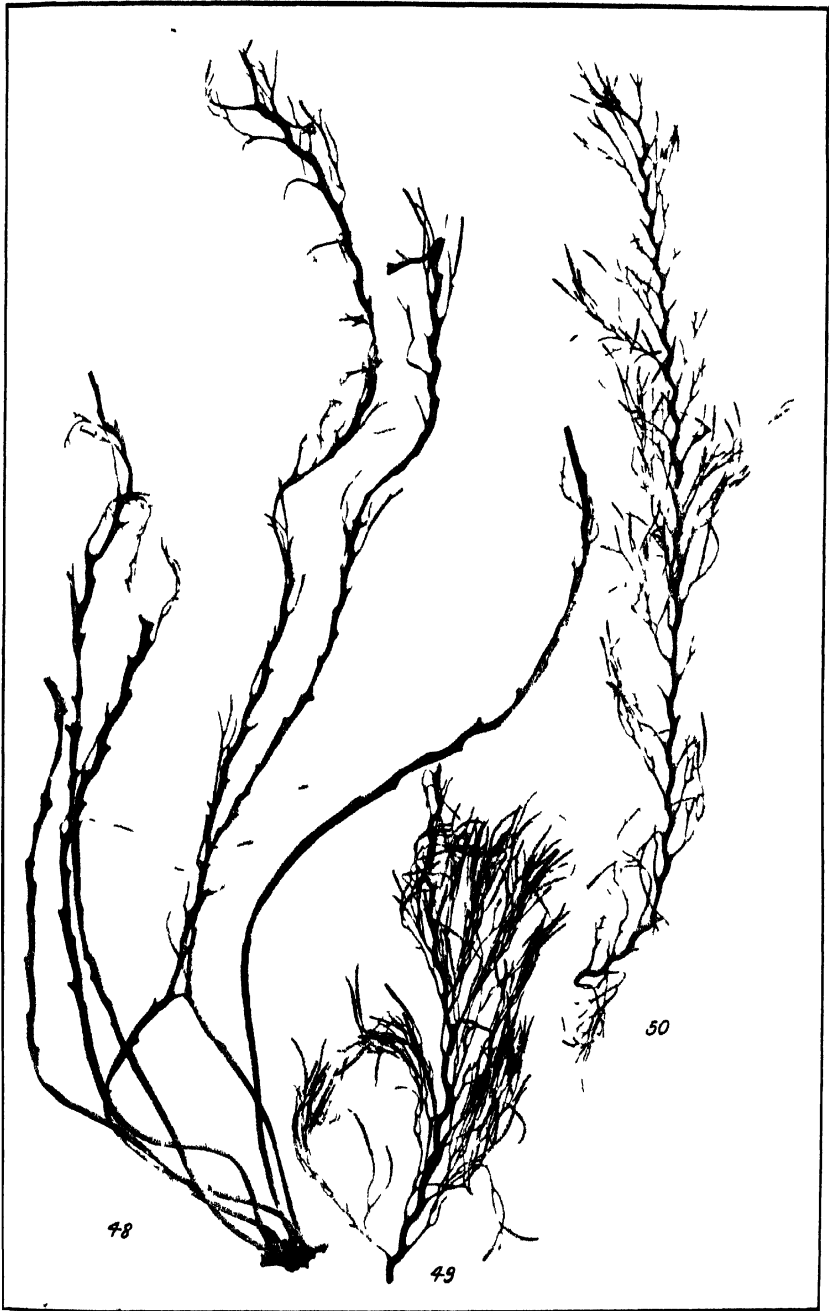


PLATE 47

Cystoseira Setchellii sp. nov.

Fig. 51.—A young sterile frond.

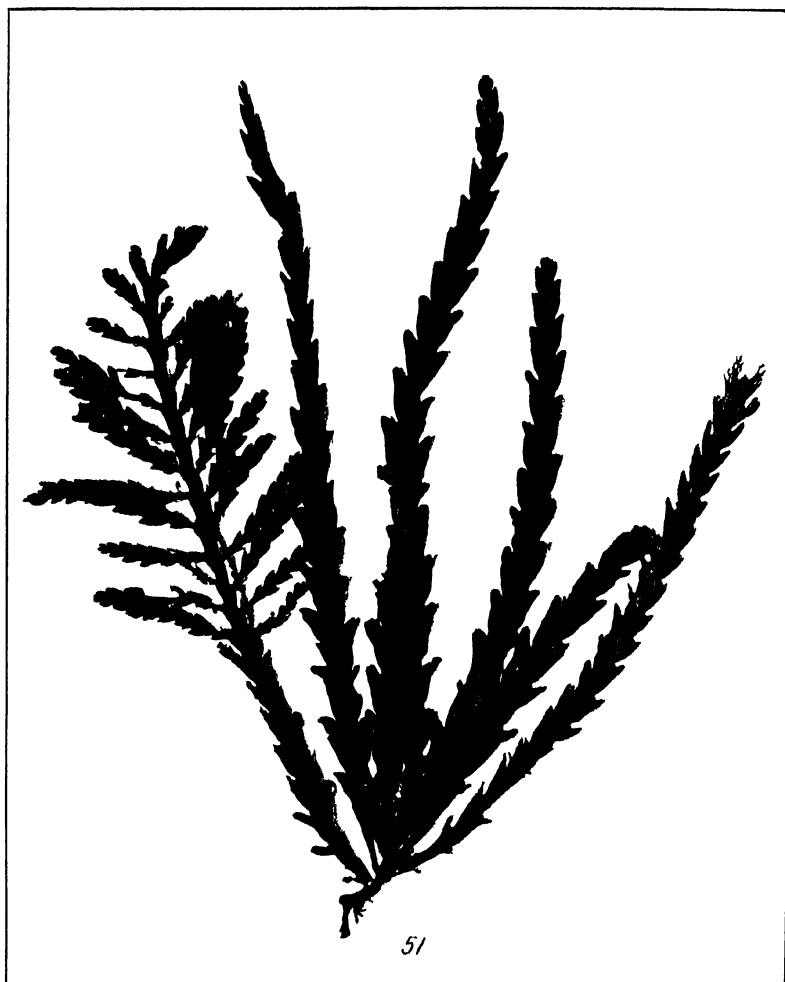


PLATE 48

Cystoseira Setchellii sp. nov.

Fig. 52.—Part of a typical plant just beginning to fruit.

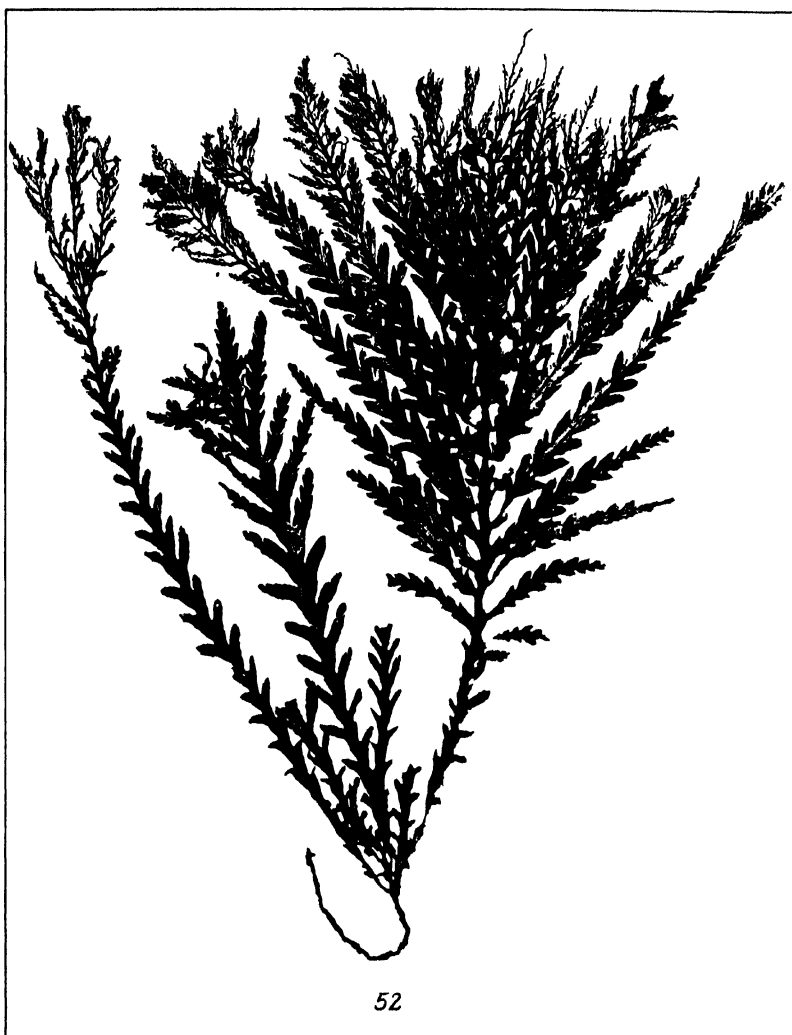


PLATE 49

Cystoseira Setchellii sp. nov.

Fig. 53.—A mature fruiting plant.

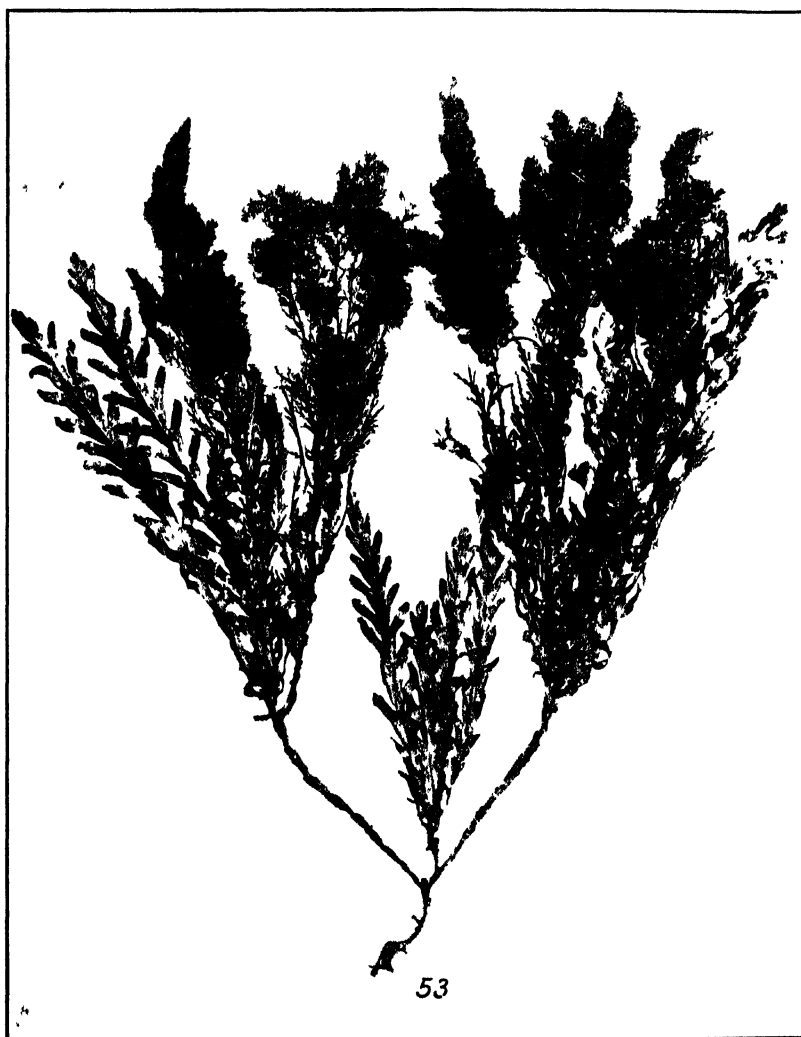


PLATE 50

Cystoseira Setchellii sp. nov.

Fig. 54.—Terminal portion of a frond showing the flattened serrated branches with air vesicles at their bases and a few vesicles at the bases of the fruiting branchlets.

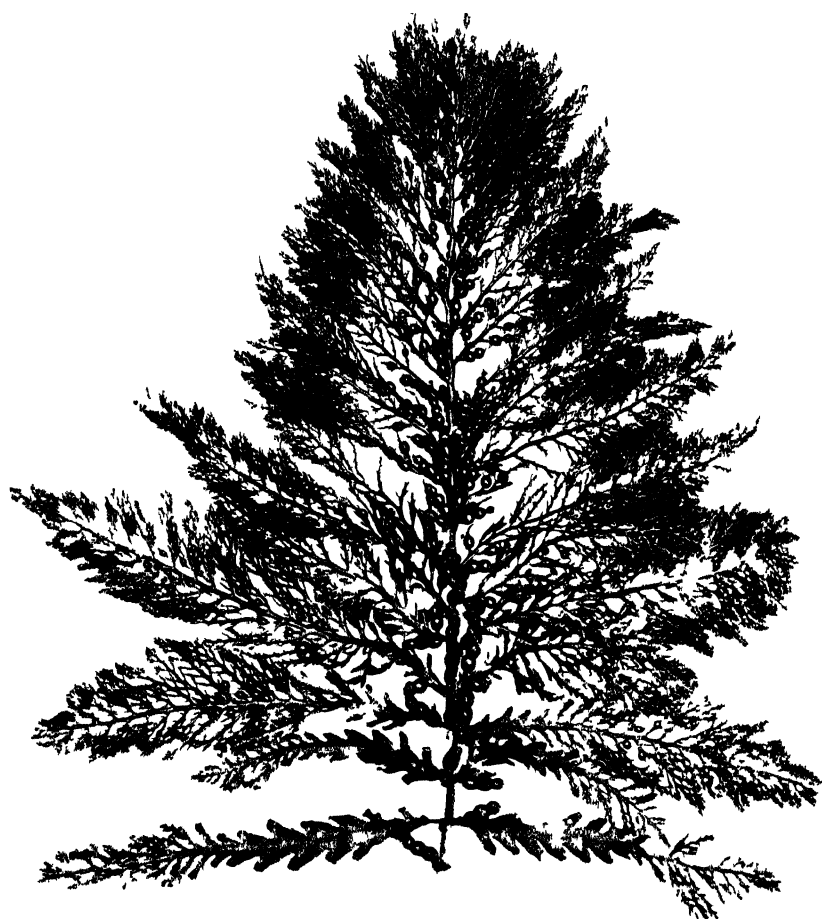


PLATE 51

Cystoseira Osmundacea (Menz.) Ag.

Fig. 55.—Portion of a typical frond in fruit.



PLATE 52

Cystoseira Osmundacea (Menz.) Ag.

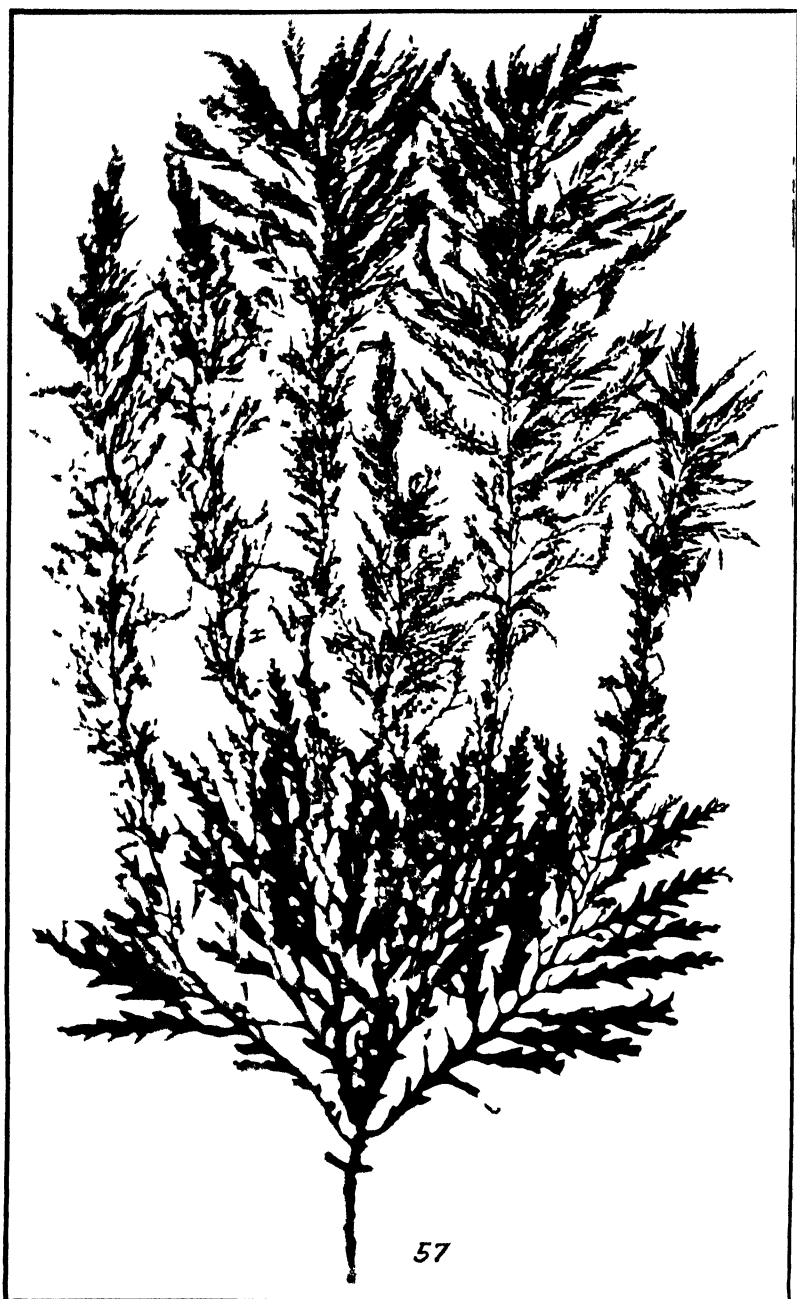
Fig. 56.—Typical fruiting branches showing the position and arrangement of the vesicles with respect to the receptacles which occupy the terminal ramuli. One-quarter natural size.



PLATE 53

Cystoseira Osmundacea f. *expansa* (Ag.) Setchell.

Fig. 57.—Plant just beginning to fruit.



PLANTAE MEXICANAE PURPUSIANAE, V

BY

TOWNSHEND STITH BRANDEGEE

The collection of plants made by Dr. Purpus last year came mainly from the State of Vera Cruz. Misantla, Naolineo, Antigua and Baños del Carrizal in the State of Vera Cruz. The Sierra Madre between Misantla and Naolineo and Baños del Carrizal seems never to have been previously visited by a botanical collector and consequently many new or rare plants were found there.

Illicium floridanum Ellis was collected by Dr. Purpus between Misantla and Naolineo. The foliage differs somewhat from the typical form, but some variation must be allowed. The species is a native of the southeastern United States and its range is greatly extended by the discovery. Poisonous effects appear to be attributed to *Illicium* wherever it is found. The natives in the Sierra Madre claim that it poisons horses, and its common name among them is "Matacaballos."

***Asimina? Purpusii* sp. nov.**

Frutex? cortice cinereo: ramis vetustis, glabris, juvenibus pubescentibus: foliis alternis, ellipticis, utrinque acutis, supra glabris, subtus ad venas pubescentibus, margine integris, 6 cm. longis, 2-3 cm. latis; petiolis pubescentibus, 2 mm. longis: floribus axillaribus, solitariis; pedicellis 5 mm. longis: sepalis 3, late lanceolatis, 5 mm. longis, extus pubescentibus; petalis 6, patentibus, puberulis, 18 mm. longis, 7 mm. latis, apice acutis; staminibus numerosis; antherarum connectivo apice peltato; stylis brevissimis; toro convexo: carpellis immaturis 6-10, 4-6-

spermis, clavatis, parum torulosis, 2 cm. longis, basi solidis stipitiformibus; ovulis biserialibus.

Perhaps this plant should be described as a *Porcelia*; its generic position appears somewhat uncertain. Collected near Baños del Carrizal. No. 6276. Type, Herb. Univ. Calif., No. 168706.

***Benthamantha tuberosa* sp. nov.**

E radicebus tuberiferis multicaulis, suffrutescens: caulibus pubescentibus, ca. 1.5 dm. altis: foliis 3–4 cm. longis, 5-foliolatis; foliolis oblongo-ovatis, basi cuneatis vel rotundatis, supra fere glabris, subtus parce pubescentibus, 10–20 mm. longis, ca. 10 mm. latis, petiolulatis; petiolis pubescentibus; stipulis subulatis: racemis folios subaequantibus, paucifloris: calycis tubo dentibus aequilongo: carina subrostrata: legumine lineari, 4 cm. longo, glabro, ca. 16-spermo.

This species seems to be very distinct from *B. Greenmaniana* (Millsp.) Britten; the other species having roots bearing tubers. Collected at Baños del Carrizal. No. 6080. Type, Herb. Univ. Calif., No. 155244.

***Coursetia polyphylla* sp. nov.**

Fruticosa ramosa: ramorum cortice albo, glabro: foliis ca. 6 cm. longis, imparipinnatis; foliolis sepius 6-jugis, supra glabris, subtus puberulis, oblongis, apice rotundatis vel emarginatis, apiculatis, margine integris, basi rotundatis vel cuneatis, petiolulatis, usque ad 3.5 cm. longis, 1.5 cm. latis; stipulis subulatis pubescentibus: racemis axillaribus, multifloris, quam foliis multo brevioribus: calyce pubescenti, 5-dentato, dente uno angustiori; vexillo emarginato, alas carinamque subaequantibus; carina breve rostrata: legumine ca. 6 cm. longo, anguste lineari, 3–5-spermo, margine undulato.

The connective of the anthers of the flowers examined is black. The color of the flowers seems to have been ochroleucous with a reddish tinge. Collected at Baños del Carrizal. No. 6076. Type, Herb. Univ. Calif., No. 155245.

***Calopogonium flavidum* sp. nov.**

Volubile, undique flavido-hirsutum: foliis pinnatim 3-foliolatis, foliolo terminali ovato, basi apiceque acuto, 9 cm. longo, 5.5 cm. lato, lateralibus valde obliquis; petiolo usque ad 14 cm. longo; stipulis lanceolatis: floribus pallide caeruleis, prope

apicem pedunculi longi, fasciculatim racemosis; calyce bracteato, bracteis calycis lobis 5, lanceolatis 5 mm. longis, similibus; pedicellis brevibus, basi bracteatis; vexillo obovato, calycem paululo superanti, alis longiori; carina obtusa, parva: ovario hirsuto, 7-ovulato.

The specimens have no mature fruit but the young legumes and flowers are those of *Calopogonium*. The raceme is not decidedly nodose. Collected at Antigua. No. 6275. Type, Herb. Univ. Calif., No. 168303.

Oxalis (*Lotoxalis*) **camporum** sp. nov.

Multicaulis e radice lignosa: caulibus basi frutescentibus, pubescentibus cum pilis adpressis adscendentibus simul pilis longioribus patulis, 2-3 dm. altis: foliolis oblongo-linearibus, apice acuminatis vel rotundatis, basi cuneatis, usque ad 2.5 cm. longis, 1 cm. latis; petiolis 2.5 cm. longis; pedunculis ca. 2.5 cm. longis; pedicellis 5-10 mm. longis: floribus umbellatis; sepalis ovato-lanceolatis, 5 mm. longis; petalis flavis, quam sepalis duplo longioribus; staminibus longioribus pubescentibus; filamentis sine appendiculis; stylis pubescentibus; stigmatibus bilobatis: capsulis oblongis, quam sepalis longioribus, deinde pendulis, angulis pubescentibus; cellulis 4-spermis.

This is the only *Lotoxalis* with unappendaged filaments credited to Mexico. Collected on rocky plains near Baños del Carrizal. No. 6038. Type, Herb. Univ. Calif., No. 149896.

Euphorbia (*Trichero stigma*) **latericolor** sp. nov.

Suffrutescens ramosa: caulibus glabris: foliis alternis, ovatis, acuminatis, utrinque tomentulosis, 2.3 cm. longis latisque; petiolis 3 cm. longis: cymis laxe 10-12-cephalis, axillaribus vel terminalibus; pedunculis pubescentibus, 2 cm. longis; pedicellis 3-4 mm. longis; glandulis transverse oblongis; appendicibus rubidis, 1.5 mm. longis, margine crenatis; stylis usque ad basim bifidus: capsula glabra: seminibus ovatis, foveolatis simul tuberculatis.

Nearest *E. fulgens* Karw. which has like colored appendages to the glands. Collected at Baños del Carrizal. No. 6119. Type, Herb. Univ. Calif., No. 155184.

Pedilanthus Purpusii sp. nov.

Frutex glaber: foliis obovatis, acuminatis, margine integris, basi cuneatis, ca. 1.5 dm. longis, 8 cm. latis; nervo medio valde prominenti; petiolis 1 cm. longis: involucri breviter pedicellatis,

pubescentibus, calceiformibus, rubescentibus; glandulis in fundo appendicis 2; labio superiori bipartito, lobis acuminatis, apice reflexis; labio inferiori lobis fimbriatulis: filamentis hirtis; loculis antherarum deinde divaricatis; stylo breviter trifido: capsulis oblongis, glabris.

This is near the description of *P. Pavonis* Boiss., but the inflorescence and shape of the leaves are different. The nearly sessile few flowered cymes are arranged racemosely near the ends of the branches. The specimens lack floral leaves and mature fruit. Collected near Zacuapan. No. 5759. Type, Herb. Univ. Calif., No. 155224.

Cuphea Purpusii sp. nov.

Fruticulus plus quam 3 dm. altus, ramosissimus: ramis tenuibus, curvatis; juvenibus hirsutis simul hirtello-glandulosis: foliis ovatis vel oblongo-ovatis, acuminatis, basi cuneatis, 5–5.5 cm. longis, 1.5–2 cm. latis, supra glabris vel setulis paucis brevissimis scabriusculis, subtus paululum hirtellis; petiolis ca. 4 mm. longis, hirtellis: racemis simplicibus, caules terminantibus, 8–10 cm. longis, pubescentibus: floribus oppositis; pedicellis ca. 5 mm. longis, ebracteolatis; calycibus 8 mm. longis, pilosis, basi gibbosis; lobis subaequalibus; staminibus 9, staminodiis 2; petalis 4 albo-purpureis, anguste spatulatis, 2 brevioribus ca. 4 mm. longis, $\frac{2}{3}$ longiorum aequantibus: seminibus ca. 10, levibus: disco erecto, ovarii adpresso.

The four spatulate petals are almost white. Collected along Rio de los Pescados, Baños del Carrizal. No. 6147. Type, Herb. Univ. Calif., No. 149833.

Tibouchina Purpusii sp. nov.

Plus quam 2.5 dm. alta, undique setulis patulis brunneis vel purpureis instructis, ramosa suffrutescens: caulibus subteretibus: foliis oblongo-ovatis acuminatis, basi rotundatis, margine indistincte serrulatis, ciliatis, 3.5–5 cm. longis, 2–2.5 cm. latis, 3–5-nerviis, utrinque parce setosis; petiolis 5–10 mm. longis: ramulorum apicibus, paucifloris; calyce urceolata, setis glanduliferis instructo; lobis quam tubo 5 mm. longo brevioribus, lanceolatis, dentatis; petalis ut videtur albis, 1 cm longis; staminibus 10, glabris, inaequalibus; connectivo majorum basi breviter producto; minorum tuberculato: seminibus cochleatis.

As the ovary matures the glands disappear from the bristles of the calyx. Collected on the Sierra Madre between Misantla and Naolinco. No. 6104. Type, Herb. Univ. Calif., No. 146822.

***Centradenia salicifolia* sp. nov.**

Suffrutescens, ramosa, plus quam 3 dm. alta: caulibus tetragonis, angulis subalatis, vetustis glabris: foliis lanceolatis in eodem jugo valde inaequalibus, usque ad 13 mm. longis, 3 cm. latis, in petiolum brevem attenuatis, basi 3-4-nerviis, margine ciliatis utrinque fere glabris: paniculis ad apices ramulorum multifloris: calyce ore constricto, 4-lobato, parce hirsuto, 5 mm. longo; lobis deltoideis, brevibus: petalis purpureo-albis, 5 mm. longis; staminibus 8, iis *C. inaequilateralis* similibus sed majoribus.

This is a larger plant than *C. inaequilateralis*, to which it is very similar. The leaves are of a thicker texture and the veins more prominent. The stems, except the youngest, are glabrous and the larger more numerous flowers are differently arranged. Collected on the Sierra Madre above Misantla on wet rocky slopes. No. 6103. Type, Herb. Univ. Calif., No. 146824.

***Triolena radicans* sp. nov.**

Herba perennis, adscendens: caulibus simplicibus, prope basim radicanibus, hirsutis, ca. 2 dm. longis: foliis oblongo-ovatis, acuminatis, subtus interdum purpureis, ad venas hirsutis, supra parce pilosis, basi inaequalibus, margine undulatis vel breviter serratis setoso-ciliatis, usque ad 12 cm. longis, 7 cm. latis, in eodem jugo inaequalibus; petiolis 2-3 cm. longis, hirsutis: spicis 10-15 cm. longis, 15-20-floris; pedunculis hirsutis; pedicellis 3 mm. longis, interdum alatis: calyce setosis; lobis deltoideis, 5; petalis 5, roseis: staminibus 10, dissimilibus; filamentis glabris; antheris 5 alternis connectivo basi incrassato; ceteris antice appendicibus clavatis 2 antheras aequantibus instructis: capsula obpyramidata, trigona, apice trialata, trivalvata: seminibus breviter clavatis, asperulis.

Only a few fruiting plants with scanty flower buds were collected. The stamens have the characters of *Diolena*, a South American genus but the calyx is that of *Triolena*. The specimens agree with the description of *T. scorpioides* in the Revision of Melastomaceae by Cogniaux except that the stems are creeping and root at the lower joints and the anthers are not exactly generic. Collected on the Sierra Madre between Misantla and Naolinco. No. 6102. Type, Herb. Univ. Calif., No. 168606

Menodora intricata sp. nov.

Herbacea glabra: ramis intricatis, valde costatis: foliis bracteiformibus, linearibus vel trifidis, ca. 4 mm. longis: floribus ramos terminantibus; calycis lobis ca. 10, linearibus, acuminatis, 5 mm. longis, corollae tubum aequantibus; corolla flava; lobis oblongis, obtusis, 6 mm. longis; stigmatate late bilobato: fructu erecto, calycem aequante.

The specimens have no lower leaves and the upper leaves are inconspicuous. The much branched stems are strongly ribbed. Collected near Minas de San Rafael, San Luis Potosi. No. 5016. Type, Herb. Univ. Calif., No. 157499.

Philibertia dumetorum sp. nov.

Volubilis: caulibus retrorsum pubescentibus: foliis orbiculato-ovatis, basi profunde cordatis, apice obtusis, acuminatis vel emarginatis, apiculatis, margine integris usque ad 5.5 cm. longis, 4 cm. latis, supra parce pubescentibus, subtus pallidioribus, pubescentibus; petiolis ca. 15 cm. longis: umbellularum pedunculis, pedicellisque ca. 1.5 cm. longis: calycis segmentis ovato-acuminatis, extus pubescentibus; corolla rotata; lobis ovato-acuminatis, 5 mm. longis; corona exteriori tenui cyathiformi, 3 mm. alta, columnam superanti; squamis coronae interioris membranaceis, magnis, ante siccationem verisimiliter rotundato-inflatis: stigmatate vertice depresso. Folliculi desunt.

Few plants were collected and from them most of the flowers had fallen. Collected near Baños del Carrizal. No. 6013. Type, Herb. Univ. Calif., No. 155247.

Cynanchum mexicanum sp. nov.

Caulibus glabris: foliis oblongo-lanceolatis, acuminatis, basi rotundatis, supra glabris, subtus minute hirtellis, ca. 5 cm. longis, 1 cm. latis; petiolis ca. 5 mm. longis: umbellis 15-20-floris; pedunculis 3-4 cm. longis; pedicellis 1 cm. longis, pubescentibus: calycis segmentis ovato-acuminatis, 3 mm. longis: corolla rotata, fere ad basim lobata; lobis ovatis, 5 mm. longis; coronae squamis 5, carnosae, oblongis, stigmam superantibus, columnae brevi adnatis, basi cum membrana conjunctis; stigmatate obtusis. Folliculi ignoti.

The stems are not twining. In accordance with the classification of Schumann in *Pflanzenfamilien* this species is described as a *Cynanchum*. It belongs to *Vincetoxicum* § *Seutera* as

defined by Gray. Collected in the State of Vera Cruz at either Baños del Carrizal or Antigua. No. 6017. Type, Herb. Univ. Calif., No. 149950.

Vincetoxicum (Gonolobus) **megacarpum** sp. nov.

Volubile: caulibus parce hirsutis; foliis late ovatis, longe acuminatis, basi auriculato-cordatis, sinu lato, margine hirtello-ciliatis, utrinque parce hirtellis; petiolis usque ad 3 cm. longis; umbellis axillaribus, ca. 6-floris; pedunculis 1 cm. longis; pedicellis 5 mm. longis; calycis segmentis lanceolatis, ciliatis 7 mm. longis; corolla campanulato-rotata, 7 mm. alta, usque ad medium 5-lobata; lobis deltoideis, obtusis, reticulatis, utrinque glabris; columna brevissima; corona brevissime annulata, cum squamis 5 carnosis, magnis deinde atris, stigmam superantibus, instructa; stigmatibus radianti, vertice depresso: folliculis 7 cm. longis, acuminatis, tuberculoso-muricatis.

The corona is unlike that of any other described species of *Gonolobus*. Collected near Baños del Carrizal, Vera Cruz. No. 6014. Type, Herb. Univ. Calif., No. 149859.

Vincetoxicum (Gonolobus) **saepimentorum** sp. nov.

Volubile: caulibus glabris vel bifariam tomentosus; juvenibus tomentosus: foliis oppositis, ternis quaternisque, ovatis, longe acuminatis, basi auriculato-cordatis, utrinque fere glabris, usque ad 6 cm. longis, 3.5 cm. latis; petiolis 2.5 cm. longis; racemis quam foliis multo longioribus, 3-8 cm. longis, multifloris; pedicellis 3 mm. longis; calycis segmentis oblongo-acuminatis, ciliatis, extus pubescentibus, 3 mm. longis; corolla fere usque ad basim 5-lobata; lobis oblongis, obtusis, 4 mm. longis; corona ad basim columnae, corollae adnata, annulata, alte 5-lobata, cum squamis 5, crasso-carnosis interioribus, apice incrassatis, stigmam aequantibus, instructa; columna tenui, brevi; stigmatibus 5-radiato, plano. Folliculi ignoti.

The arrangement of the leaves, the long peduncles and peculiar corona well characterize this species. Collected at Baños del Carrizal, growing in hedges. No. 6019. Type, Herb. Univ. Calif., No. 149949.

Ipomoea melanotricha sp. nov.

Volubilis, suffruticosa: caule hirsuto pilis nigrescentibus reflexis, 5 mm. longis; foliis in circumscriptione orbicularibus, diametro usque ad 13 cm., glabris, alte pedatim 7-lobatis, basi

cordatis; lobis lineari-ovatis, acuminatis, basi angustatis: pedunculis 8.5 cm. longis, hirsutis; pedicellis hirsutis, ca. 4 cm. longis, apice incrassatis; sepalis aequalibus, dense hirsutis, oblongis, apice obtusis, 2 cm. longis: corolla purpurea, infundibulari, 8 cm. longa; stigmatibus capitato, bilobo: ovario 2-loculari. Fructus deest.

This species is near *I. setosa* Ker. but has a very different leaf. Collected at Zacuapan. No. 5747. Type, Herb. Univ. Calif., No. 163009.

***Ipomoea carrizalia* sp. nov.**

Caulis parum volubiles, striati, puberuli: foliis triangulari-ovatis, usque ad 9 cm. longis, 6 cm. latis, integris vel trilobatis, apice obtusis vel acutis, basi cuneatis, supra paululo tomentosus, subtus dense albo-tomentosus; petiolis 2 cm. longis: pedunculis 2.5–7 cm. longis, puberulis, apice 1–5-floris; pedicellis 1–1.5 cm. longis: sepalis coriaceis, subaequalibus, ovatis, apice obtusis, 6 mm. longis; corolla rosea, infundibulari, 6.5 cm. longa, basi tubo 1 cm. longo; stigmatibus 2, globosis: ovario 2-loculari; loculis 2-ovulatis: capsula breve ovoidea, sepala superanti, in valvas 2 ab apice dehiscenti: seminibus glabris, e basi densissime longissimeque lanatis.

Collected on rocky plains near Baños del Carrizal. No. 6241. Type, Herb. Univ. Calif., No. 167863.

***Ipomoea pusilla* sp. nov.**

Volubilis e radice annua: caulibus filiformibus, parce pilosis, 2–3 dm. altis: foliis subpedato-5-lacinatis; laciniiis anguste ovatis, exterioribus laciniiatis, setaceo-acuminatis, margine ciliatis, supra hirsutulis; petiolis 1 cm. longis: pedunculis unifloris, 2.5 cm. longis, ultra medium bibracteolatis: sepalis lanceolatis, subaristo-acuminatis, aequalibus 4 mm. longis, dorso leviter carinatis, exterioribus hirsutis: ovario 2-loculari, 4-ovulato: stigmatibus capitato subgloboso, bilobo: seminibus juvenibus lanatis.

The leaves resemble those of *I. leptotoma* Torr. and *I. costellata* Torr. The specimens are young and have buds only, but the corollas are evidently to be small with acuminate lobed margins. Collected on plains near Baños del Carrizal. No. 6152. Type, Herb. Univ. Calif., No. 149878.

***Ipomoea ursina* sp. nov.**

Caulis crassus, pilis vel setis fulvis, longis, patulis, instructus: folius paululo pilosis, ca. 6 cm. longis, 4 cm. latis, cordato-ovatis, integris vel alte trilobis, lobo medio majori acuminato; petiolis

2.5–3.5 cm. longis: floribus 15–20 cymoso-paniculatis; pedunculis crassis pilosis, 11 cm. longis; pedicellis ca. 2 cm. longis; sepalis coriaceis subaequalibus, oblongis, obtusis; exterioribus pilosis; corolla alba, 6 cm. longa, tubuloso-infundibulari, limbo parum patenti; antheris inclusis; stigmatibus 2, globosis: ovario 2-loculari, loculis 2-ovulatis. Fructus deest.

Collected at Baños del Carrizal. No. 6240. Type, Herb. Univ. Calif., No. 167862.

***Ipomoea angustata* sp. nov.**

Undique glabra, volubilis: foliis in circumscriptione cordato-ovatis, 6 cm. longis, 5 cm. latis, alte trilobis; lobo centrali multo majori, longe acuminato, basi angustato; lobis lateralibus e sinu divaricato saepe alte lobatis, folium 5-lobatum formantibus: petiolis 3.5 cm. longis; pedunculis 3–3.5 cm. longis, apice bracteolatis, 1–3-floris; pedicellis 5–10 mm. longis: sepalis 7 mm. longis, fere filiformibus, basi latis subito angustatis; corolla infundibulari, 2 cm. longa: capsula ovoidea, 2-loculari, sepalis breviori, ab apice dehiscenti: stigmatibus globosis.

The dried flowers are pink in color. The capsules examined had matured but a single seed in each cell. Collected at Culiacan, Sinaloa, by T. S. Brandege, Sept. 1904. Type, Herb. Univ. Calif., No. 105148.

***Ipomoea iodantha* sp. nov.**

Volubilis, caulibus parce pilosis: foliis cordato-ovatis, acuminatis, apiculatis, usque ad 10 cm. longis, 8 cm. latis, sinu 2.5 cm. profundo, 7 mm. lato, fere glabris, subtus minute albo-maculatis; petiolis 5–10 mm. longis: pedunculis 1.5–2.5 cm. longis, apice 3–5-floris, bracteis foliaceis, pilosis, lanceolatis, 2 cm. longis, sepalis similibus, instructis; pedicellis ca. 2 mm. longis: sepalis 1.8 cm. longis, lanceolatis, pilis e basi pustulata hirsutis; corolla infundibulari, 2.5 cm. longa, superne violacea, tubo flavido: ovario 2-loculari; loculis 2-ovulatis.

The flowers are crowded into a head amongst the bracts. Collected by T. S. Brandege at La Mesa, Cape Region of Baja California, Oct., 1902, and near Culiacan, Sinaloa, Sept., 1904. Type, Herb. Univ., No. 105204.

Ipomoea ornithopoda Robinson was collected by Dr. Purpus at Baños del Carrizal, extending the range of the species from the Pacific to the Atlantic coast. The leaves of the plant vary very much. Specimens from Culiacan, Sinaloa, collected at the

same time and locality have the usual deeply parted leaves and on the same plant nearly entire ones, merely dentate.

Ipomoea konzattii Greenman has been collected by Dr. Purpus at Tehuacan, a northward extension of its previously known range.

***Jacquemontia pauciflora* sp. nov.**

Annual: caulibus erectis longe pilosis simul pilis brevibus intermixtis, usque ad 3 dm. altis, basi interdum recte ramosis: foliis ovato-acuminatis, basi cordatis, supra stellato-hirsutis, subtus adpresse villosis, 2.5 cm. longis, 1.8 cm. latis; petiolis 6–20 mm. longis; pedunculis axillaribus 2-floris, 2–2.5 cm. longis; pedicellis ca. 1 cm. longis, glanduloso-hirtellis: corolla caerulea, 7 mm. longa, quam sepalis hirsutis ovato-acuminatis duplo longiori; stigmatibus oblongis; capsula globosa, glabra, quam sepalis breviori: seminibus rugosis.

This species in general appearance most resembles *J. Palmeri* Wats. differing in leaves not punctate, in pubescence and other characters. Collected at Baños del Carrizal. No. 6139. Type, Herb. Univ. Calif., No. 155183.

***Breweria sulphurea* sp. nov.**

Fruticosa: caulibus aliquando volubilibus, pubescentibus: foliis late ovatis, apice acuminatis, obtusis vel minute mucronulatis, supra pubescentibus viridibus, subtus dense flavido-tomentosis ca. 7 cm. longis, 4.5 cm. latis; petiolis 2 cm. longis; floribus cymosis ad axillas foliorum parvorum ramulorum foliosorum: pedicellis 1.5 cm. longis, pubescentibus: sepalis flavido-tomentosis, ovato-lanceolatis, aequalibus, 1–3 cm. longis: stylo alte bifido; stigmatibus capitatis: ovario hirsuto, 2-loculari, 4-ovulato: corolla extus flavido-hirsuta, infundibuliformi, 1.5 cm. longa: capsula subconica, quam sepalis breviori, apice flavido-hirsuta.

The flowers are numerous from the axils of small leaves of branches, about 6 cm. long, that come from the axils of the large leaves of the main stem. The color of the corolla seems to have been a very light blue. Collected at Baños del Carrizal. No. 5998. Type, Herb. Univ. Calif., No. 155241.

***Heliotropium petraeum* sp. nov.**

Fruticulus cinereo cortice ramosissimus: ramis juvenibus strigoso-pilosis: foliis lanceolatis, utrinque attenuatis, sessilibus, 3.5 cm. longis, 3–5 mm. latis, strigoso-pilosis, subtus albidis:

floribus ad apices ramorum dichotome cymosis, ebracteatis; cymarum ramis ca. 1.4 cm. longis; segmentis calycis lanceolatis, 1.5 mm. longis, albo-strigosis: corolla quam calyce duplo longiori; lobis acuminatis, extus strigoso-hirsutis; fauce intus hirsuta; antheris ovatis apiculatis: fructibus strigoso-hirsutis, 4-separalibus.

This little bush was collected on rocky slopes near Baños del Carrizal. No. 6180. Type, Herb. Univ. Calif., No. 149914.

***Athenaea Purpusii* sp. nov.**

Frutex: cortice cinereo; ramis erectis, junioribus pubescentibus: foliis alternis, ovato-acuminatis, ca. 5 cm. longis, 3.5 cm. latis, basi in petiolum attenuatis, margine integris, utrinque puberulis; petiolis ca. 1 cm. longis: floribus fortasse juvenibus, axillaribus, solitariis, nutantibus: pedicellis ca. 1 cm. longis; calyce primum 4 mm. longo, pubescenti; corolla campanulata, viridi, parva, fere usque ad basim lobata, lobis valvatis: staminibus 5, corollae prope basim adnatis; antheris quam filamentis dilatatis brevissimis multitoties longioribus, loculis parallelis demum in longitudinem dehiscens: calyce fructifero, aucto, inflato, membranaceo, 2 cm. longo, dentibus conniventibus.

This plant has the fruiting calyx of a *Physalis* but is described as an *Athenaea* because: it is a bush; its large anthers have short, dilated filaments that are attached to the corolla; the corolla is deeply lobed. Few specimens were collected and although they have both flowers and large, inflated, fruit-bearing calyces, there is still some uncertainty about the development of the flowers. Collected at Baños del Carrizal. No. 6225. Type, Herb. Univ. Calif., No. 155246.

***Russelia Purpusii* sp. nov.**

Frutescens: caulibus ramisque teretibus, pubescentibus: foliis oppositis, late ovato-acuminatis, margine integris, usque ad 6 cm. longis, 4 cm. latis; superioribus bracteiformibus; supra glabris, subtus pubescentibus; petiolis 5 mm. longis: cymis axillaribus, pedunculis ca. 7 mm. longis, pedicellis aequalibus, 3-6-floris: calycis segmentis ovato-acuminatis, brevibus: corolla coccinea, cylindracea, 1.5 cm. longa: capsula ovato-acuminata.

Collected at Baños del Carrizal in rocky forests. No. 6039. Type, Herb. Univ. Calif., No. 149897.

Jacobinia albicaulis sp. nov.

Fruticosa, ramosa: caulibus vetustis cortice albedo; juvenibus pubescentibus, luteo-viridibus: foliis oppositis, ellipticis, obtuse acuminatis, margine integris, basi in petiolum marginatum cuneatis, ca. 9 cm. longis, 3.5 cm. latis, supra puberulis, subtus pubescentibus, flavescentibus: floribus cymoso-spicatis vel paniculatis ramos terminantibus: pedunculis 3-floris, ca. 4 mm. longis, pedicellis aequilongis, bracteis lineari-lanceolatis: calyce campanulato, 7 mm. longo, usque ad medium 5-lobato; lobis late lanceolatis; corolla coccinea, 18 mm. longa; labio postico erecto, breviter bilobato; labio antico usque ad basim tripartito, lobo intermedio majori, palato incrassato; staminodia 2; staminibus 2; ad medium tubi affixis; loculis antherarum linearibus, muticis, uno altius affixo; ovario disco cupulato imposito, 4-ovulato: stylo incluso pubescenti. Fructus deest.

This species is characterized by its white stems and branches, its deeply lobed anterior lip, its campulate almost deltoid-lobed calyx and the presence of staminodia. The calyx is broad and somewhat recalls that of some *Labiatae*. Collected near Baños del Carrizal. No. 6049. Type, Herb. Univ. Calif., No. 149880.

Tetramerium geniculatum sp. nov.

Herbaceum; caulibus pubescentibus, basi geniculatis ad nodos radicantibus: foliis ovato-lanceolatis, basi cuneatis, utrinque hirtellis, ca. 9 cm. longis, 3 cm. latis; petiolis 2.5 cm. longis: spicis terminalibus, ca. 8 cm. longis; bracteis exterioribus ovato-lanceolatis, pinnato-nervosis, setoso-ciliatis; nervo medio valido, apice excurrenti; bracteis interioribus linearibus, ciliatis: calycis segmentis 4, linearibus: corolla purpurea, lobis brevibus; antherarum loculis disjunctis. Fructus deest.

The exterior bracts somewhat resemble those of *T. hispidum* but it is easily distinguished by its pinnate instead of parallel veins; otherwise it is very different. Collected in damp shady forests near Misantla. No. 5956. Type, Herb. Univ. Calif., No. 166384.

Tetramerium nemorum sp. nov.

Ramosum: caulium vetustorum cortice albo; juniorum pubescenti: foliis late ovatis, acuminatis, basi truncatis vel subcordatis, utrinque puberulis, ca. 2 cm. longis, 1.7 cm. latis; petiolis pubescentibus, 12 mm. longis: floribus spicatis ramos terminantibus:

bracteis exterioribus obovatis, acuminatis, mucronatis, pubescentibus; interioribus lineari-lanceolatis, ciliatis: calycis segmentis 5, lineari-lanceolatis, ciliatis: corolla albo-purpurascenti: ovulis 4.

Collected at Baños del Carrizal in rocky forests. No. 6071. Type, Herb. Univ. Calif., No. 146830.

Rondeletia heteranthera sp. nov.

Frutex ramis teretibus glabris: foliis ovatis, acuminatis, basi rotundatis, utrinque glabris, 9 cm. longis, 4.5 cm. latis; stipulis acutis, persistentibus; petiolis 4 mm. longis: floribus in cymas paniculatas dispositis, axillaribus; paniculis 4-5 cm. longis, multifloris: calycis tubo subgloboso, laciniis 4, parvis; corolla infundibulari, tubo angusto, elongato, 8 mm. longo, fauce parum ampliata, extus puberula, ore nuda; lobis 4, imbricatis; staminibus 4, corollae insertis inclusis; filamentis brevibus; antheris dorso medio affixis, elongatis, linearibus; loculis basi usque ad filamentum disjunctis; stylo filiformi, ramis 2 brevibus: ovario 2-loculari; ovulis in loculis numerosis: capsulis parvis, globosis, coriaceis, primum septicide dehiscentibus, polyspermis: seminibus angulatis, exalatis.

This plant does not have the obtuse anthers and loculicidal dehiscence of *Rondeletia*. *Rondeletia gracilis* as exemplified by Pringle's No. 6135 has similar bifid anthers, and a septicidal dehiscence has been noticed in other species of the genus. Collected at Baños del Carrizal. No. 6148. Type, Herb. Univ. Calif., No. 155217.

Elaterium heterophyllum sp. nov.

Caulibus parce pubescentibus striatis: foliis membranaceis, majoribus leviter trilobatis, 13 cm. longis, 10 cm. latis, apice acuminatis, mucronatis, margine undulato-dentatis, basi cordatis, sinu angusto, 3-4 cm. profundo, utrinque glabris vel minute punctulato-scabriusculis; petiolis 6 mm. longis, pubescentibus; foliis minoribus hastatis vel leviter 5-lobatis; floribus masculis in umbellis ca. 10-floris; pedunculis pubescentibus, usque ad 10 cm. longis; pedicellis ca. 6 mm. longis; calycis dentibus filiformibus, brevissimis; tubo 16 mm. longo, quam corollae laciniis linearibus duplo longiori; antheris in capitulum oblongum connatis; floris femineis calyce et corolla mari similibus: cirrhis bifidis, pubescentibus: ovario dense hirsuto: fructu immaturo dense setosis.

Collected at Antigua, growing in moist soil of shaded localities. No. 6149. Type, Univ. Calif. Herb., No. 149834.

Laurentia insignis sp. nov.

Herbacea: caulibus sulcatis fere glabris, plus quam 2 dm. altis: foliis ovato-lanceolatis, utrinque attenuatis, glabris, margine crenato-dentatis, 6.5 cm. longis, 3 cm. latis; petiolis ca. 2 cm. longis: floribus axillaribus; pedicellis 7 cm. longis; calycis tubo hemisphaerico, diametro 7 mm.; lobis brevibus, dentatis: corolla bilabiata; tubo dorso breviter fisso, 3 cm. longo; lobis lanceolatis, 7-10 mm. longis: staminum tubo corollae ima basi adnato; filamentis usque ad medium facile separandis, tomentosis, longissime exsertis: antheris vertice setis rigidis instructis, praesertim duabus, glabris; stigmate alte 2-fido: ovario semisupero.

The appearance of this plant is that of a *Lobelia*. The dried flowers have a tinge of red. Collected on the Sierra Madre between Masantla and Naolinco. No. 6227. Type, Herb. Univ. Calif., No. 167930.

Tridax Purpusii sp. nov.

Annua, hirsuta: caulibus erectis, ca. 3 dm. altis; ramulis brevibus, basilaribus, paucis; foliis ovato-acuminatis, dentatis, in petiolum brevem cuneatis, ca. 4 cm. longis, 2 cm. latis: capitulis 3-4, caules terminantibus; pedunculis 12-18 cm. longis; involucri squamis aequalibus biseriatis, exterioribus ovato-acuminatis, extus hirsutis; interioribus oblongis, apiculatis, membranaceis; corollis radii ligulatis, 6 cm. longis, longe tubulosis; ligulis luteis, quadratis, trifidis; pappi setis florum disci angustissimis, aristato-acuminatis, plumosis, achaenia duplo longioribus; squamis florum radii brevibus, oblongis, ciliatis: achaeniis disci sericeo-villosis; radii minus villosis.

Collected near Naolinco. No. 6035. Type, Herb. Univ. Calif., No. 149895.

Pinaropappus caespitosus sp. nov.

Glaber, caespitosus, humilis, ca. 7 cm. altus: foliis radicalibus spatulatis, acuminatis, ca. 3 cm. longis: scapis monocephalis: involucri squamis oblongo-acutis; floribus purpureis: achaeniis longe rostratis, striatis; pappi setis uniserialibus.

Collected at Boca del Monte, Puebla. No. 5816. Type, Herb. Univ. Calif., No. 164174.

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ERRATA

- Page 27. For *hypercifolia* read *hypericifolia*
 Page 127, line 21. For *amplictentibus* read *amplectentibus*
 —, line 28. For *festigiata* read *fastigiata*
 Page 143, line 15. For *pinnatifidia* read *pinnatifida*
 Page 204, line 6. For *4-merous* read *numerous*
 Page 335, line 15. For *Halidrys Osmundaceus* read *Halidrys Osmundacea*
 (as on pages 306, 333).
 Page 333, line 8 from the bottom. For *Douglassi* read *Douglasii*

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